Research & Policy INsights

A Look at Broadband Access, Providers and Technology

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Advancing Collaboration : Energizing Regions

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⊞ *Introduction*

The Federal Communications Commission (FCC) publishes a bi-annual dataset based on data submitted by internet service providers using Form 477. This dataset provides information at the Census block level, the most granular geography used by the U.S. Census Bureau, on types of technologies available (e.g. Cable, Fixed Wireless, Fiber-optic, etc.), maximum advertised download/ upload speeds, and providers' names among other information.

However, this dataset has several limitations. First, data is not granular enough and if a household or business in a particular block has access to any technology, the entire block is considered "covered". Second, speeds are maximum advertised speeds and not actual speeds. Lastly, the data is carrier self-reported and is not validated by consumers or third-party entities. These limitations tend to overestimate coverage of broadband technology.

Regardless of these limitations, this dataset (December 2017 v2) can provide valuable information for local planners and policymakers, such as but not limited to:

• Which providers have the largest footprint in the country?
• Which technologies offer the highest or lowest advertised
  download/upload median speeds?
• How does provider competition look like overall and in
  urban/rural areas?
• Are there differences between urban/rural locations
  regarding speeds, providers, and/or technology?

A total of 7.65 million Census blocks and 21.17 million records were analyzed[1]. About 3.61 million or 47.3 percent were urban blocks, 2.76 million or 36 percent were rural, and the remaining 16.6 percent were not assigned an urban/rural category[2]. Total population was 325.7 million living in 137.3 million housing units and 1,877 providers submitted information.

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[1]Census blocks with no population and housing units were removed, even if providers reported available technology. Analysis excludes U.S. territories. Fixed broadband technologies were included except for satellite. Only records where providers can or do offer consumer/mass market/residential service were included (Consumer =1).

[2]Urban/rural categories were obtained from the Decennial 2010 Census and since FCC population and housing units 2017 estimates were used, some 2017 blocks did not have a 2010 urban/rural designation.

Broadband Access

As the FCC has publicized, the data show that 21.3 million people or 6.5 percent of the U.S. population did not have access to advertised 25 megabits per second (Mbps) download and 3 Mbps upload, or 25/3 for short. In terms of housing units, about 9.8 million or 7.1 percent did not have access to 25/3.

Note however, that the share of rural housing units (26.9 percent) without access to 25/3 was almost **20 times larger** than the urban share (1.4 percent), indicating a sizable urban-rural divide. Table 1 shows the percent of population and housing units with access to 25/3.

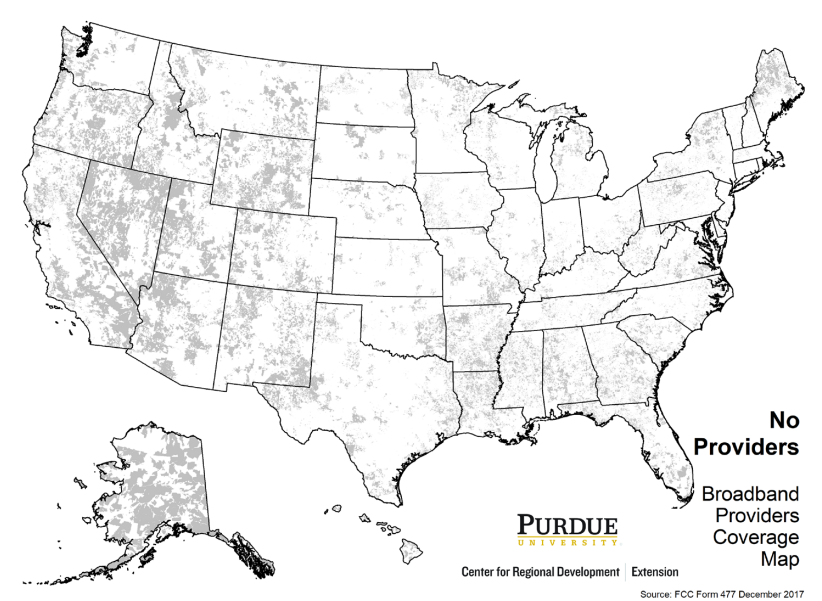**Table 1.** *Population and Housing Units with Access to 25/3*

Item	Total	Access 25/3	No access 25/3	% no access 25/3
Population	325,716,075	304,405,315	21,310,760	6.5
Urban	256,898,427	253,702,066	3,196,361	1.2
Rural	62,303,723	46,251,856	15,778,867	25.3
Housing Units	137,399,683	127,619,406	9,780,277	7.1
Urban	107,198,006	105,704,465	1,493,541	1.4
Rural	29,027,722	21,216,612	7,811,110	26.9

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Moreover, of the 21.3 million people or 9.8 million housing units with no access to 25/3, 4.8 million people or 2.2 million housing units had access to no providers whatsoever—defined here as digital deserts—regardless of the speed threshold (gray areas). Of these, more than two-thirds (69.5 percent) or 1.53 million housing units were in rural blocks. These digital deserts are shown in Figure 1. Remember that Census blocks with no housing units or population were removed from the dataset.

The west has many of these digital deserts as does Alaska. A lack of population density and vast distances between potential customers may be one of the reasons. However, there are digital deserts in areas surrounded by coverage such as the Arkansas and Mississippi delta as well as the southeast corner of Oklahoma, to mention a few. This suggests there may be other factors at play other than density and sparsely populated areas.

Figure 1.

Digital Deserts—Census blocks (gray) with no broadband providers

No Providers

Broadband Providers Coverage Map

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Source: FCC Form 477 December 2017

Given that many businesses and homes now use the internet for productivity, rather than entertainment purposes, the need for symmetrical connections is increasingly important. Symmetrical connections are those that have identical download and upload speeds. For example, the current 25/3 FCC definition is asymmetrical. For this reason, we also looked at the footprint of symmetrical 25/25 access. The share of housing units without access to symmetrical 25/25 speeds is much higher than those without access to 25/3 as shown in Table 2. Close to two-thirds of rural housing units (64.7 percent) compared to 27.1 percent of urban did not have access to this symmetrical speed.

Table 2. *Population and Housing Units with Access to 25/25*

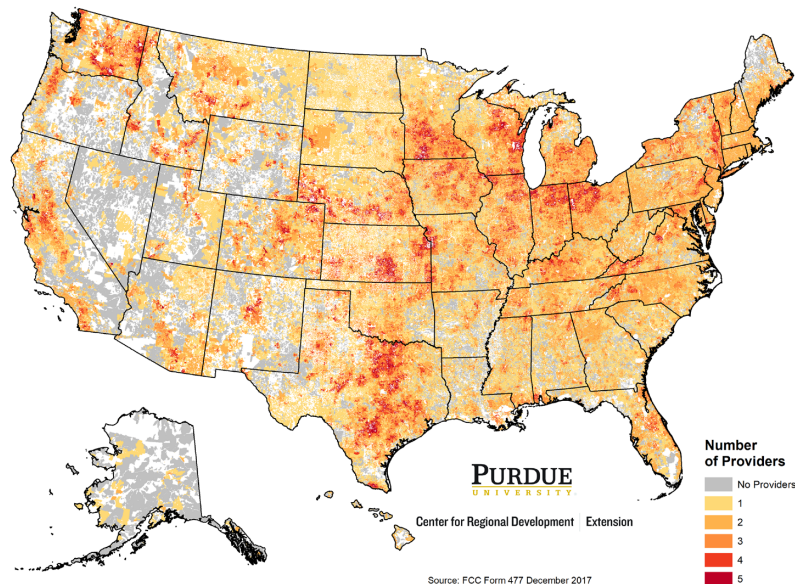| Item	Total	Access 25/25	No access 25/25	% no access 25/25
Population	325,716,075	215,345,728	110,370,347	33.9
Urban	256,898,427	189,817,356	67,081,071	26.1
Rural	62,303,723	22,796,853	39,233,870	63.2
Housing Units	137,399,683	88,802,034	48,597,649	35.4
Urban	107,198,006	78,107,701	29,090,305	27.1
Rural	29,027,722	10,242,579	18,785,143	64.7

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Broadband Providers

A total of 1,877 providers submitted data using Form 477 for the December 2017 v2 dataset. Remember that only providers that can or do offer consumer/mass market/residential service in Census blocks with housing units or population were included. The number of providers reporting advertised 25/3 service drops to 1,334 and further drops to 887 reporting advertised symmetrical 25/25.

Figure 2.

Provider Density by Census Block

Figure 2 shows the number of providers per census block (darker orange indicates a higher number of providers per Census block) as well as those areas with no providers (gray). As expected, urban areas in general had a higher number of providers in the same Census block.

Figure 3 indicates that one-quarter of housing units in rural areas had access to only one provider, compared to 2.7 percent of urban housing units. Likewise, almost half of urban housing units had access to three or more providers compared to less than one-third of rural housing units.

Table 3 shows the top 6 providers that served 10 percent or more of the housing units in the country. The total number of housing units considered (i.e. all housing units in the nation) was 137.3 million. The provider with the largest footprint was AT&T serving 53.6 million housing units or

Figure 3.

Percent Housing Units with Access to Providers

Source: PCRD; FCC Form 477

about 39 percent of all housing units. AT&T had also the largest footprint in urban areas serving almost 45 percent of urban housing units followed by Comcast with 41 percent. Charter, on the other hand, served a higher share of rural housing units (a little more than one-fifth) followed by AT&T with 19.3 percent.
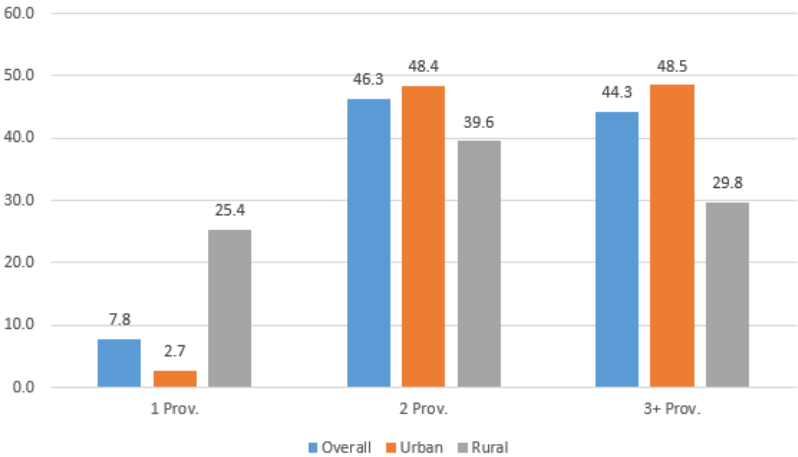
Table 3. *Providers Serving Ten Percent or more of Housing Units*

Name	Housing Units (HU)	Percent HU	Urban HU	Percent Urban HU	Rural HU	Percent Rural HU
AT&T	53,631,384	39.0	47,823,617	44.6	5,611,501	19.3
Comcast	48,455,518	35.3	44,308,603	41.3	4,037,617	13.9
Charter	44,920,776	32.7	38,125,773	35.6	6,495,942	22.4
Verizon	24,051,293	17.5	21,662,787	20.2	2,326,881	8.0
CenturyLink	22,614,792	16.5	17,424,658	16.3	5,063,492	17.4
Frontier	15,002,972	10.9	11,253,311	10.5	3,662,150	12.6
Total (All U.S.)	137,399,683	---	107,198,006	---	29,027,722	---

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Collectively, these top 6 providers served 124 million housing units or 90.5 of the total, about 97 percent of urban housing units, and 67.6 percent of rural housing units. Their footprint is shown in Figure 4. Notice how in Maine, for example, the main top 6 provider is Charter while in Mississippi it is AT&T. On the other hand, Verizon has a strong presence in the northeast but no presence elsewhere. Remember that white areas in the map are either served by other non-top 6 providers or had no providers at all. Census blocks with no housing units or population were not included in the analysis.

Figure 4.

Top 6 Providers' Footprint

ATT
Charter
Comcast
CenturyLink
Verizon
Frontier

Broadband Providers Coverage Map

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Source: FCC Form 477 December 2017
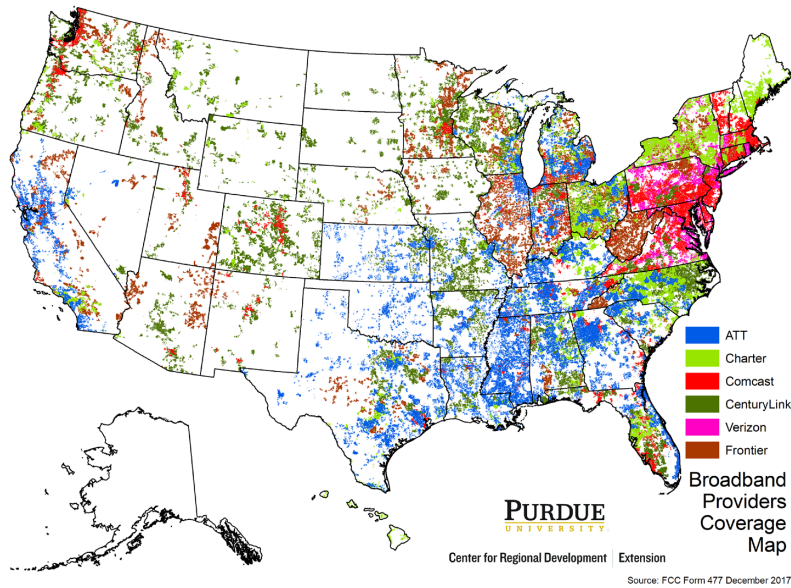
How much overlap is there between Top 6 providers and other providers? Figure 5 shows four layers: the orange layer indicates where top 6 and non-top 6 providers overlap; the blue layer indicates where Top 6 providers were the only providers (darker blue indicates a higher number of top 6 only providers); the green layer indicates where other (non-top 6) were the only providers (darker green indicates a higher number of other providers only).

Notice how the majority of the plains is served by other (green) providers while the southeast and parts of the northeast are primarily served by top 6 providers only (blue). A combination of both top 6 and others (orange) is visible in the Midwest as well as western Virginia and the northeast (Maine, Vermont, New Hampshire).

Also notice how the majority of Arkansas, Louisiana, and Mississippi are served by one top 6 provider only (light blue) while the majority of North and South Dakota are served by one other provider only (light green). Iowa stands out for being served by multiple other only providers (dark green) while the mid-Atlantic region and parts of Florida are served by multiple top 6 only providers (dark blue).

Table 4 shows the percent of housing units in the footprint of the top 6 and other providers only, including cooperatives[3]. The top 6 only footprint (blue layer) covered 35 percent of housing units in the

Figure 5.

Broadband Providers by Group

All Providers

Top 6 Only
1 Provider
2 Providers
3 Providers

Other Only
1 Provider
2 Providers
3+ Providers

No Providers

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Source: FCC Form 477 December 2017

country, almost forty percent of urban housing units, and close to one-quarter of rural housing units. In the end, top 6 only providers served 48 million housing units, of which 5.3 million were served by one top 6 provider only. This compares to 10.9 million served by other providers only, of which also 5.3 million housing units were served by one provider.

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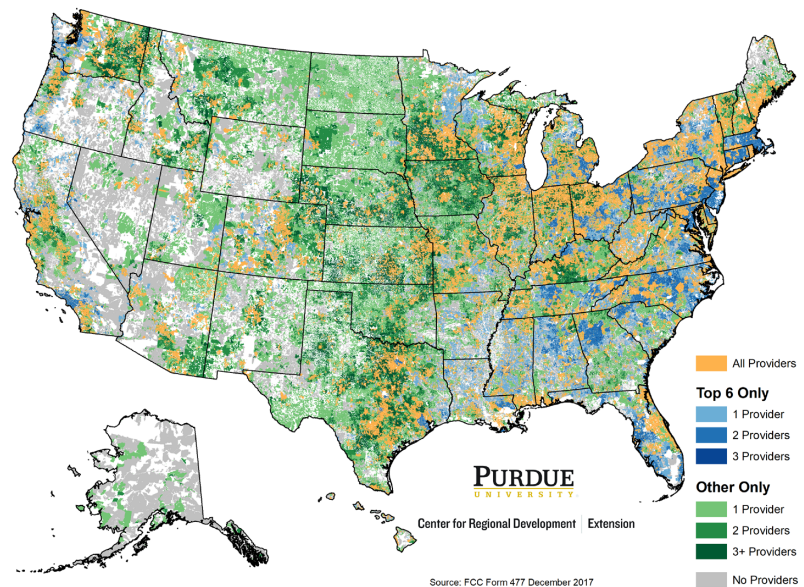
[3]A total of 206 cooperatives were identified by searching the name of providers in the dataset.

Notice however that the share of rural housing units being served by only one top 6 provider was much higher compared to urban housing units (11.1 versus 1.8 percent). Notice also how the share of other providers only was higher in rural versus urban (27 versus 2.6 percent). Likewise, cooperatives served a higher share of rural (4.4 percent) versus urban (0.1 percent) housing units.

Table 4. *Housing Units Served by Top 6, Other, and No Providers*

Provider	Housing Units (HU)	Percent HU	Urban HU	Percent Urban HU	Rural HU	Percent Rural HU
Top 6 Only	48,032,756	35.0	40,631,181	37.9	7,129,412	24.6
1 Prov.	5,343,008	3.9	1,966,940	1.8	3,219,194	11.1
2 Prov.	42,056,446	30.6	38,130,670	35.6	3,814,037	13.1
3 + Prov.	633,302	0.5	533,571	0.5	96,181	0.3
Other Only	10,901,135	7.9	2,756,209	2.6	7,860,892	27.1
1 Prov.	5,316,541	3.9	968,652	0.9	4,147,886	14.3
2 Prov.	3,554,189	2.6	1,064,909	1.0	2,427,997	8.4
3+ prov.	2,030,405	1.5	722,648	0.7	1,285,009	4.4
Cooperatives	1,430,071	1.0	132,910	0.1	1,274,183	4.4
No providers	2,205,048	1.6	410,550	0.4	1,532,951	5.3

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Broadband Technologies

In our work with communities, the question of which technology should be invested in always comes up. Every broadband technology has its advantages and disadvantages and without a doubt, it will take a combination of technologies to ensure affordable and adequate connectivity across the country. However, we analyzed the most popular broadband technologies by the only metric available in the dataset: maximum advertised download and upload speeds in megabits per second (Mbps). And remember, these are advertised, not actual speeds.

Another technical point worth discussing is that median speeds—rather than average—were utilized. Median values are more accurate since they include the value at the middle of the range of values available. In other words, half the values will be higher than the median while the other half will be lower. Averages, on the other hand, can be heavily influenced by outliers—for example, a network providing a few locations with 1 gigabit speeds while most of their offerings are less than 10 Megabits.

Table 5 showcases the number and percent of housing units with access to the most popular broadband technologies by census type (urban or rural) as well as their median maximum advertised download and upload speeds. And since we are using medians, it is necessary to include the number of records (range of values) analyzed. Remember that urban and rural figures will not add up to the total since there were blocks with no urban/rural designation (see Footnote 2, on page 1).

Table 5. *Analysis of Broadband Technologies*

Technology	DSL[4]	Fixed Wireless	Cable[5]	Fiber-optic
Housing Units (HU)	121,858,592	55,656,307	121,142,069	42,483,049
Percent HU	88.7	40.5	88.2	30.9
Urban Housing Units	99,384,037	42,610,546	104,641,550	37,494,556
Percent Urban HU	92.7	39.7	97.6	35.0
Rural Housing Units	21,971,145	12,537,614	15,996,489	4,778,919
Percent Rural HU	75.7	43.2	55.1	16.5
Media Down (Mbps)	15.000	15.000	400.000	940.000
Urban	18.000	15.000	400.000	940.000
Rural	10.000	12.000	300.000	1,000.000
Median Up (Mbps)	1.000	3.000	20.000	880.000
Urban	0.768	4.000	30.000	880.000
Rural	1.000	3.000	20.000	150.000
Records	9,219,647	4,865,549	5,267,064	1,724,982
Urban	5,923,931	2,171,790	3,801,119	1,139,754
Rural	2,559,092	1,958,524	999,256	430,098

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Overall, the technologies with the largest footprint were DSL followed closely by Cable, serving 88.7 and 88.2 percent of housing units respectively. Less than a third of housing units (30.9 percent) in the country were served by fiber-optics. As expected, a higher share of rural housing units were served by fixed wireless compared to urban (39.7 versus 43.2 percent) while the rural share is lower for access to DSL (92.7 versus 75.7 percent), Cable (97.6 versus 55.1 percent), and fiber-optics (35 versus 16.5 percent). Regarding speeds, fiber-optics had the highest—and close to symmetrical—advertised speeds, followed by cable. On the other hand, the slowest technology was DSL followed by fixed wireless. In fact, the median download/upload speeds for these did not meet the 25/3 broadband criteria.

Interesting to note too is that the median advertised speed, both download and upload, is lower in rural compared to urban regardless of technology (except for the fiber-optic and DSL upload speeds). Perhaps the demand for higher speeds is lower in rural areas and therefore providers have less incentive to advertise it even if the technology can offer it. Or it can be that the electronics in rural areas are not at the same level of urban resulting in lower speeds (this is particularly true for DSL, whose quality degrades with distance from the central office providing it). Something to point out is that DSL, the technology with the largest footprint in the nation (and an outsized presence in rural areas), performed the worst with a median download speed of 15 Mbps and a median upload speed of 1 Mbps across 9.2 million records.

[4]Includes Asymmetric xDSL, ADSL2, ADSL2+, VDSL, and symmetric xDSL
[5]Includes DOCSIS (1,1.1,2.0,3.0, and 3.1) and other cable non-DOCSIS technologies

Table 6 shows median speeds by group of providers, including cooperatives. Urban areas had access to higher download/upload median speeds regardless of provider type. For example, consider areas where only one top 6 had a presence: urban median speeds were 120/10 versus 12/1 in rural. Competition among top 6 providers generally resulted in higher advertised speeds, particularly in rural locations.

Table 6. *Median Speeds for Specific Provider Groups*

Provider Group	Top 6 Only	Top 6 – 1	Top 6 – 2	Top 6 – 3	Other Only	Cooperatives
Median Down (Mbps)	30	18	50	50	20	25
Urban	75	120	75	75	30	20
Rural	18	12	25	25	20	25
Median Up (Mbps)	5	2	10	5	4	3
Urban	10	10	10	10	6	2
Rural	2	1	2	2	3	4
Records	5,358,101	888,136	4,422,406	47,559	8,924,531	317,845
Urban	3,815,899	155,059	3,624,017	36,823	4,318,865	16,459
Rural	991,961	485,267	498,525	8,169	3,552,022	263,157

Source: PCRD; FCC Form 477; Note: urban and rural will not add up to totals due to undefined areas. See footnote 2.

Overall, top 6 only outperformed other only (including cooperatives) in median advertised speeds, more so in areas where top 6 only competed with themselves. However, other (including cooperatives), outperformed top 6 only in rural despite top 6 competing with each other.

◢ *Conclusions*

Although the Form 477 data has serious limitations, it is the only dataset available regarding broadband-related information at the national level. Even when keeping these limitations in mind, it is possible to extract valuable information that can better guide policies and jumpstart discussions around this critical 21st century technology. Below is a list of the key findings from this analysis.

- **Digital deserts exist:** often overlooked or even unknown until now is that of the 21.3 million people without access to 25/3 as reported by the FCC in their latest broadband progress report, almost five million people and/or 2.2 million housing units had access to no providers. More worrisome, more than two-thirds of these unserved housing units were in rural areas. These digital deserts should be targeted for urgent broadband-related investments (see Figure 1).

- **Access divide persists:** the urban-rural access divide persists despite improvements in both urban and rural areas. The share of rural population without access to 25/3 was almost 20 times larger than the urban share (see Table 1). Moreover, when using a symmetrical 25/25 speed, the share of housing units without access was five times higher compared to 25/3 (see Tables 1 & 2). Likewise and regarding median advertised speeds, digital parity is still nonexistent since urban areas have access to higher median advertised speeds regardless of broadband technology available and type of provider (except for cooperatives).

- **Provider competition:** the vast majority of housing units in the country (98.4 percent) had access to an internet provider and 90.6 percent had access to two or more providers. However, while only 2.5 percent of urban housing units had access to only one provider, one-quarter of rural housing units had access to only one provider (see Figure 3). Collectively, the top 6 providers only (not including other providers) served 48 million housing units (about 35 percent of all housing units); of these, 5.3 million were served by only one while 42.6 million were served by two or more. In addition, top 6 only providers served about 38 percent of urban housing units compared to close to one-quarter of rural housing units (see Table 3 & Figure 4). Of the 10.9 million housing units served by other providers (non-top 6), 7.8 million were in rural areas compared to 2.7 million in urban. Also and included in the other category, about 1.4 million housing units were served by cooperatives (see Table 4 & Figure 5).

- **Broadband technology:** DSL technology has the largest footprint in the country but also had the lowest median advertised speeds. Although fiber-optics advertised the highest download and upload speeds and by far closer to offering symmetrical speeds, only a little less than one-third of homes in the nation had access to it (only 16.5 percent in rural areas). Also, areas with multiple providers advertised higher median speeds in general while advertised speeds in urban were higher than rural regardless of provider type, except cooperatives (see Tables 5 & 6).

- **Better align subsidies and incentives:** given that other (non-top 6) providers serve a larger share of rural housing units and offer faster median advertised speeds in these areas (especially cooperatives), efforts need to be made to ensure these providers receive existing incentives and subsidies to build or upgrade broadband networks. Likewise, since competition resulted in higher overall advertised speeds, overbuilding concerns need to be revisited.

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