Spectrum-sharing is essential for rural networks

Introduction

The importance of wireless access – and therefore spectrum – for rural communities and users is increasing rapidly, both for personal and business / government purposes. In addition to traditional mobile broadband connectivity, there is growing need for wireless connectivity in rural communities for precision agriculture, transportation, public safety, utility field-workers and other emerging uses.

This article highlights the need for policymakers to include a rural lens more often when considering spectrum sharing.

Rural economic growth, social welfare and access to fundamental services such as education and healthcare all hinge on better access to the Internet, cloud and business connectivity. And that in turn depends on access to suitable spectrum resources. But critically, it also depends on timely and broad deployments of networks which make good use of that spectrum.

Speed is of the essence here; theoretical arguments about "efficiency" of a given approach are irrelevant if nothing actually happens. Disappointingly, networks suitable for advanced 5G services have so far only been deployed on a fraction of the footprint of nationwide, exclusive spectrum licenses awarded to the major carriers.

Rural communities are therefore constrained by these firms' top-down business plans, which effectively determine if and when their local area is deemed "worthy" of proper 5G coverage. At the moment, too many rural communities don't have any (or limited) access to 5G. With the current slowing pace of deployment, some can expect to wait years for enhanced public mobile coverage. Others may never get it.

The question is how to accelerate deployments of connectivity for those places and applications that need it most. While many operators are avidly seeking new spectrum allocations for future 5G/6G capacity, *even their own* advertised 5G coverage maps confirm they are failing to deploy their *existing* exclusive frequencies where they could make a difference for rural users.

But it does not have to be this way. Shared and unlicensed spectrum enables more agile and geographically focused deployments by alternative network owners.

Not all rural areas are the same

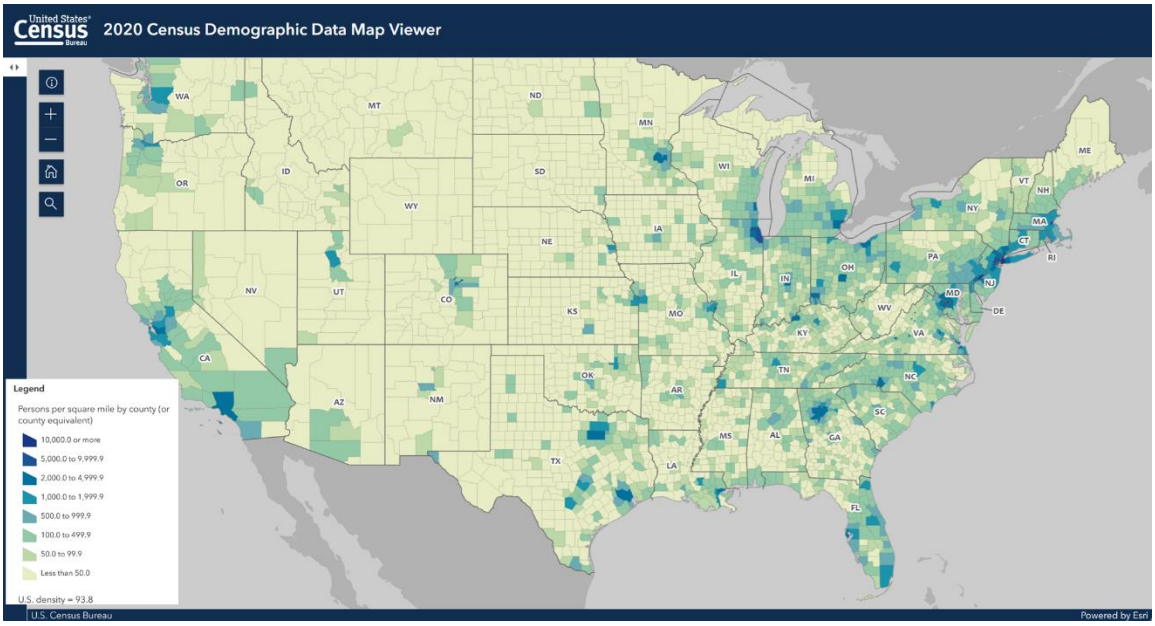
It is important to recognize that there is a huge difference between rural areas in the US. Looking at the US 2020 Census map viewer at county and census-tract granularity, it is very clear that rural areas tend to concentrate population in small towns and communities,

and that outlying areas may have a density of only 1-5 people per square mile or even lower.

Conversely, those blocks with small towns, numerous local communities and intensively-farmed land can average 100 or more residents per square mile. New Jersey's authorities estimate that around 10% of the state's population lives in areas with less than 500 people per square mile, which it deems to be "rural."

Conversely, the entire state of Wyoming has less than 6 people per square mile as an *average*. There can be a 100x difference between near-rural and remote-rural regions. For comparison, some areas of New York have over 100,000 residents per square meter, so the overall range is expansive.

This reality of population concentration has a significant impact on wireless network deployment and coverage – and the efficient use of spectrum. In more remote areas, the potential returns on investment for fixed broadband and mobile economics is challenging, especially as major companies have to find the personnel and financial resources to deploy and maintain coverage with decent performance.



Current MNO deployments are lagging

In CTIA's filing[1] to the NTIA about the National Spectrum Strategy (NSS), it noted that "*Mid-band can be a game-changing technology in rural areas, where it can provide connectivity that would otherwise be unavailable, helping to bridge the digital divide, attract telecommuting professionals, and support economic growth."*

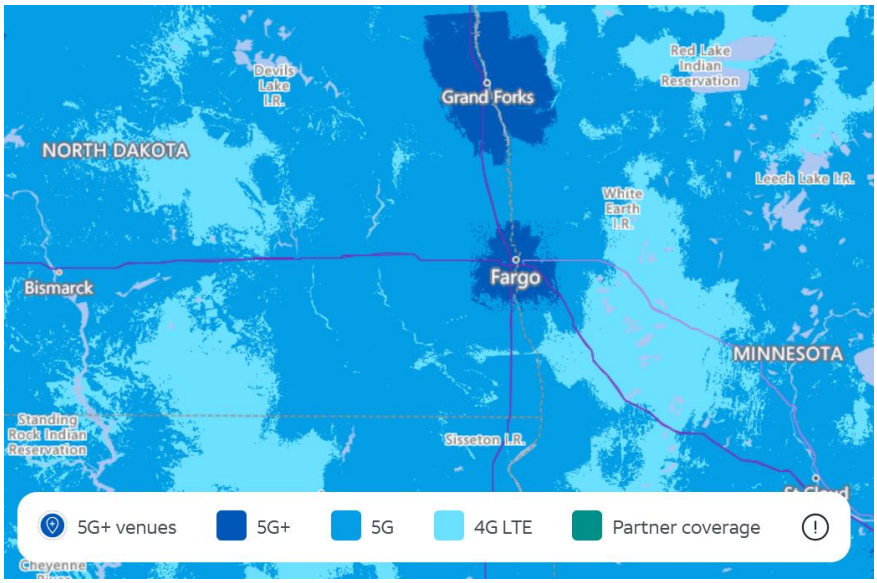
Mid-band spectrum *can* be a game-changer for rural users… *but only if it is actually deployed.* But except for areas close to major towns and highways, most rural areas are

[1] https://www.ntia.gov/sites/default/files/publications/ctia_0.pdf

at the bottom of the investment-priority list, especially in those areas inhabited by fewer than 20-30 people per square mile.

The fact that all three large operators have agreed to work with satellite direct-to-device specialists indicates they lack confidence in their own terrestrial coverage in remote areas, even for basic messaging connectivity, let alone for high-performance 5G.

In 2017, CTIA claimed that more than 99% of rural Americans have access to at least one 4G network, and that its members covered 4.3 million rural road miles. These figures do not appear to have been updated for the 5G era. The operators' own coverage maps bear this out. For most of the operators, midband 5G networks capable of supporting standalone 5G and high-capacity mobile broadband or FWA are very patchy at best.



Source: AT&T coverage map

The reality is that large portions of rural America either have no 5G coverage, or just a thin layer of low-band coverage that is not capable of supporting many of the advanced broadband capabilities promised by the industry. There is also no reliable, granular mapping or surveys, so many individual properties or areas of agricultural land are often completely lacking coverage from one or more networks.

More detail is important here, because rural communities, agricultural land and more-remote wilderness regions typically cover vast areas, often with vehicles travelling on farm tracks or logging roads, rather than normal highway and state/county routes.

5G has been pitched for precision agriculture: but where is it?

The mobile industry has been pitching 5G as a key technology for agriculture for many years. Yet despite some early proofs-of-concept and significant MNO ownership of suitable spectrum assets, large areas of American farms and forestry operations are still unable to exploit it.

In its filing to NTIA about the NSS, CTIA mentioned it several times, noting that: "*5G-enabled agriculture will empower farmers to more efficiently manage their resources…. With 5G-powered equipment that will generate massive amounts of data about their agricultural operations, farmers can maximize resources and output, cut costs, optimize crop and livestock yields, and better preserve the environment.*"

To be fair, some aspects of precision farming, such as moisture sensing, do not require huge network capacity or low latency – they can operate on quite constrained networks. But others – especially anything streaming video from cameras on drones or robots – are much more demanding.

Promising ideas such as detection and removal of weeds, monitoring of livestock vital-signs, or machinery with predictive-maintenance telemetry or remote diagnostics, need more reliable and high-capacity connectivity.

In 2022, CTIA also talked up the potential for 5G to help reduce CO2 emissions by the agricultural sector. Its report highlighted the scope for up to 28 million metric tons of CO2 "abatement" by 2025, via precision agriculture and "connected crop management," citing applications such as crop-spraying by drones and weed monitoring.

Notably, its carbon model "*assumes as a baseline that 5G networks have already been widely deployed"* across farmland, in a way that supports *"new, innovative smart technologies that previously could not be supported by 4G.*"

Oddly, CTIA has not yet issued any updates to this prediction for agricultural 5G-led CO2 abatement, nor illustrated how its members have used their existing midband spectrum assets for this purpose in rural areas. Maybe it expects a radical shift in the next 12 months?

How rural areas benefit from shared / unlicensed spectrum

While the large carriers may eventually deploy high-speed public 5G networks in *some* more deep-rural areas, if it happens at all, this will take considerable time. Rural communities should not have to wait or suffer prolonged uncertainty. The operators holding the high-power exclusively licensed spectrum currently face CAPEX constraints and other demands on their attention. They are sitting on spectrum that could be used by others, if it had been allocated more effectively in the first place – or perhaps, if it could be accessed by others on a secondary basis while it remains dormant. At a minimum, the failure of the larger operators to fully deploy and utilize their spectrum resources in rural areas is an important lesson for policymakers; they should consider a more flexible spectrum policy like shared or pooled spectrum in the future.

Rural operators, alternative providers, communities, businesses and cooperatives could take action to build local wireless networks much faster and more flexibly, if federal spectrum policies allowed them to access spectrum licenses covering smaller geographic areas and operating at lower power levels.

Examples include:

- Community-led wireless ISPs (WISPs) providing broadband in the lowest-density areas or very small towns. While these providers have long used unlicensed 2.4GHz spectrum, newer options using shared spectrum such as CBRS between 3.55-3.7GHz and now higher-power outdoor 6GHz with AFC support can accelerate adoption significantly. Higher bandwidths can enable speeds in the 10s or 100s of Mbps range, essential for supporting modern business, education and entertainment applications which urban users take for granted.
- Rural utility companies can deploy 4G/5G networks over shared spectrum for their own grid control, or to provide connectivity for field workers and their vehicles or sensors, cameras and drones for monitoring against risks such as wildfires. They need sufficient spectrum to deliver ultra-reliable and low latency wireless; for instance, to de-energize a broken powerline before it falls to a forest floor and potentially ignites a fire.
- Agricultural enterprises and cooperatives can create localized high-performance networks for precision agriculture, forestry management, livestock monitoring and worker safety. These can require much more spectrum, granular coverage and performance than a thin and patchy layer of MNO-offered 5G. For instance, they may need video uplink for real-time image analysis, delivered from tractor- or drone-based cameras.
- Fixed / cable operators can use localized shared-spectrum options to pursue targeted and competitive wireless deployments, as an adjunct to their wireline assets. This can allow them to compete at a local level, include especially hard-to-reach properties, or offer a variety of innovative hybrid and fast-to-deploy services.
- Shared or unlicensed spectrum can be used effectively for temporary or seasonal mobile networks, deployed for agricultural harvests, fairs and festivals, disaster response or tourism events. While the very largest events or emergencies can attract the carriers' "cells on wheels" (CoWs), these are not routinely deployed for small or mid-sized events that can benefit local economies.
- Private networks require shared spectrum for use at remote enterprises such as mines, wind/solar facilities, water resource management, pipelines and future "drone highways." There is also a need for coverage of private roads or railways, such as those used for farming, logging or mining. Such locations are often poorly covered by major carriers' networks, and shared spectrum is better than unlicensed for safety- or business-critical applications.

It is also worth noting that smaller rural operators and private networks are much more likely to choose innovative, and often US-based vendors for wireless deployed in shared or unlicensed spectrum. Whether that is for CBRS small cells, O-RAN based regional 5G, Wi-Fi or derivative technologies in 6GHz or cutting-edge systems in 60GHz or even optical broadband, there is a much higher role of US suppliers than in carriers' macro 5G.

Conclusion: spectrum policy needs a rural focus on sharing

Discussions to date about "spectrum efficiency" of high-power cellular radios and exclusive licenses have been misguided. Theoretical efficiency, in a vague future scenario with unknown deployment timelines has little relevance. Actual efficiency requires networks to be *actually* deployed and operational. In much of rural America, the effective

value of much 5G-capable spectrum is zero – or perhaps negative, if opportunity cost is factored in.

There is an irony here – the mobile industry often has very high urgency to see spectrum auctions rushed through, but then the complete opposite – a remarkable lack of urgency to deploy that spectrum in rural areas.

Yet it is the ability to use precision agriculture, distance learning, remote healthcare, and other applications *immediately* that will help such communities improve their local micro-economies, as well as their social situation.

This is why continued support and evolution of shared spectrum and coexistence opportunities, like CBRS and AFC-enabled 6GHz, is critical for rural users. The CBRS ecosystem is already benefiting from the recent relaxation of rules (CBRS 2.0) on dynamic protection areas and other changes. But there are potentially other enhancements that could benefit rural users, such as permitted antenna height and perhaps locally-specific adjusted power levels.

There should be much more fine-grained coverage mapping data as well – so that policymakers can understand exactly how many farm acres or isolated homesteads actually get connectivity. And this doesn't just mean one bar and a 5G logo – it means usable, high-performance signals, able to handle video streaming, precision agriculture or two-way real-time collaboration or education. This may need better surveys or crowdsourced data, or even detailed and updated maps ("digital twins") of spectrum utilization in rural areas.

While dense urban areas are obviously in need of 5G *capacity* – and generate more revenue per square mile for MNOs – that does not offset the urgent need for decent 5G *coverage* and capacity in more sparsely populated areas. The mobile industry loudly makes its own case for advanced services for farming and rural communities – but does not deliver on its own ambitions, leaving many potential valuable uses for spectrum overlooked.

Rather than criticizing the potential availability of shared spectrum for faster and more-focused rural providers, maybe the large carriers should look the other way. If they don't plan to use their *existing* spectrum assets in rural areas themselves, maybe there should be mechanisms for others to access them on a secondary basis and build networks quickly, instead? At the least, future spectrum allocations should take into account past experience and recognize the benefits that shared, locally-licensed spectrum can bring to rural America.