# Quick Wins: Using Wireless Networks to Connect the Unconnected and Underserved

Internet Speeds—Now and into the Future

If our nation is making a concerted effort to connect all Americans, at what speed should they be connected? Opinions on how much is enough varies from 25/3 Mbps (25 Mbps down and 3 Mbps up) to 100/100 Mbps. It's important, however, to recognize that this specification is for now, 2021-2022.

Historically, Internet access was offered at dial-up speeds starting at 300 bps (bits per second) in the 1960s using dial-up telephone lines and acoustic couplers. By the 1970s, 1.2-2.4 Kbps (thousands of bits per second) were commonplace and could be used at homes and businesses over ordinary telephone lines. By the 1980s, 9.6Kbps was typically offered, and by 1990, some modems could stretch that to 56Kbps. In the 1990s, cable systems came into operation and could offer a 1 Mbps (millions of bits per second) connection. Cable today can typically offer 100 Mbps or more to the home, with some versions of cable offering a gigabit down and tens of megabits up. Fiber is now fairly widely available in hundreds of urban areas at a starting speed of 1 Gbps and 2 Gbps is offered by multiple ISPs over fiber.

This growth is shown in the figure below.
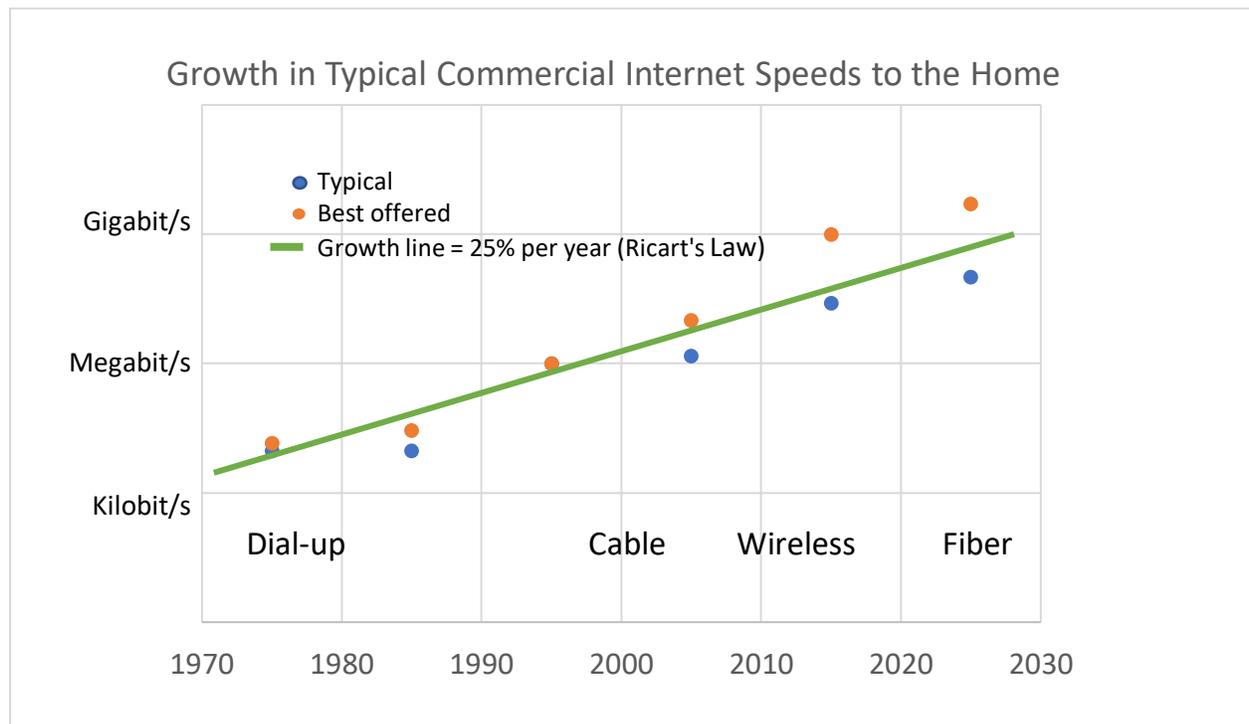
The trends demonstrated above suggest that what is considered adequate today may not be considered adequate in a few years. Federal dollars spent on connecting the unconnected and underserved should ideally be used to provide service which won't be considered inadequate in a few years.

Of all the technologies mentioned above, optical fiber has the best growth path and fiber installs should be relatively future-proof. By changing the optical components at the ends of fiber, speeds can be increased into the terabits per second range which should take us 30 or more years into the future if growth continues at the same pace.

Wireless technologies, on the other hand, are limited by Shannon-Nyquist sampling to data rates which are proportional to the wireless frequency used. To double the data rate, other things held constant, requires doubling the wireless frequency. The higher frequency will have different propagation characteristics and is attenuated much more quickly by anything in its path. In the millimeter range, even light foliage will block the wireless signal. Therefore, connecting the unconnected with wireless technologies has limited upgrade capabilities to increase speeds into the future. But it can serve as a useful quick win to buy time for other solutions such as fiber and it can provide connectivity where line-of-sight is available.

Building Fiber Deep into the Infrastructure

Building fiber deep into neighborhoods and households will be a useful backbone and backhaul for the technologies providing service to individual households and devices. We note that fiber-deep is a requirement for small cells and millimeter-wave 5G mobile and fixed service. While commercial providers including T-Mobile, Verizon, and AT&T are indeed building fiber as deeply as they can as quickly as they can, this activity is limited to areas of dense customers. Cable operators such as Charter, Cox, and Comcast often have fiber deep into their infrastructures where they've deployed hybrid fiber-coax services, and these fiber-deep infrastructures are also well situated to provide fiber-like services at least to the levels of a gigabit or a bit more. They could also be used to provide small-cell millimeter-wave services and compete with the traditional mobile providers.

Anchor institutions are also important providers of fiber-deep back-haul. We take special note of the research and education state-wide or regional networks typically members of the The Quilt. They tend to have advanced infrastructures because of the data-intensive needs of advanced research.

A national strategy to connect the unconnected should encourage all of these deep-fiber backhaul and small cell services at the edge. Any one of them won't be enough. The NTIA should consider incentives for mobile wireless, cable, anchor institutions, municipal networks, and research and education networks to work cooperatively to achieve national goals. Connecting unconnected households will depend on leveraging all of these providers for backhaul and providing cooperative interoperation at multiple exchange points in a community. For this reason, NTIA should encourage the use of community-based internet exchanges, leverage nonprofit, state, and municipal networks and anchor institutions, and also include fairly-compensated commercial providers. They can all be part of the solution. Connecting the unconnected should not depend on any one of these players alone.

Neutral Infrastructure

Neutral infrastructure will be a key way of continuing competition with the cooperation needed to achieve national goals. We note that ORAN (Open Radio Access Network) is a way to use a set of common radio antennas for multiple retail providers without the visual clutter of antennas and extensive municipal permitting required for each separate provider. This is exceptionally important for small cell deployments. Municipal conduit space should be filled with fiber that can be used as neutral backhaul infrastructure for multiple competitive providers. UTOPIA Fiber in Utah provides a low-cost

fiber-carriage service on which multiple Internet and other digital services can provide choice and competitive services.

Neutral infrastructure should be owned by governments, nonprofits, or consortia to prevent the neutral infrastructure from providing advantage to only one competitive service provider. See the Altman-Solon "Broadband Models for Unserved and Underserved Communities" portion of this US Ignite submission for further examples and information.

Quick Wins: Mobilizing Today's Resources and Building a Competitive Commercial Future

The "national emergency" tone of IIJA should be used to give anchor institutions, educational institutions, nonprofits, municipalities, counties, states, tribes, and federal agencies the green light to fill in connectivity that commercial organizations can't presently serve. We will need all hands on deck.

We have existing resources, both digital and human, in Internet2, members of The Quilt, and in Federal Agencies which could be important parts of this all-hands-on-deck effort. The Federal Agencies already have the NITRD coordinating body and the JET (Joint Engineering Team) groups ready to provide assistance. The Federal Agencies will be critical to making sure the new infrastructure is national-security resistant.

Nonprofit coordinating bodies such as US Ignite, the Institute for Local Self-Reliance, and the National Digital Inclusion Alliance should be utilized to coordinate and share best practices during this all-out connecting-the-unconnected and underserved mobilization period.

The commercial Internet-providing communications companies have a long-term interest in the success of this mobilization; in the end, it will build their customer base and feed their revenues. The commercial companies will also be able to hire knowledgeable workers who were previously trained by the mobilization providers.

Anchor institutions, educational institutions, nonprofits, and government organizations will be all too happy to transfer end-users to competitive providers leveraging neutral infrastructure after the emergency is addressed. They will undoubtedly have new emergencies that will demand their attention in the future. They might be health and/or climate related, for example.

US Ignite would expect vigorous competition from new and current mobile providers, current cable operators, and high-speed Internet providers such as CenturyLink, ATT, and Google Fiber.

We also expect many of these services will leverage neutral infrastructure operated by governments, nonprofits, and community anchor institutions (churches, libraries, healthcare facilities, etc.) at cost with a nonprofit or governmental responsibility to the communities they serve.

Quick Wins with Wireless

While we recommend longer-term solutions including fiber and other neutral infrastructures, connecting the unconnected and underserved will not wait for this transformation in every case. We will need quick wins to complement the longer-term vision. Fortunately, wireless can provide such quick wins.

Wireless is capable of providing Internet services adequate by today's standards, particularly where line-of-sight is available. The US Ignite OVERCOME project in Cleveland has demonstrated the ability of line-

of-sight 60 GHz wireless to provide gigabit backhaul capacity to a neighborhood. Further re-distribution can be provided by FCC type-certified equipment such as CBRS or WiFi6. This is a clearly successful model, and the outdoor CPE and antennas can be upgraded to higher frequencies in the next few years as long as line-of-sight is maintained.

Another US Ignite OVERCOME project in Blue River, Oregon has demonstrated how CBRS wireless radios could power WiFi hotspots to re-connect students and their families after the 270 square mile Holiday Farm Fire destroyed the existing Internet infrastructure.

In rural Missouri, Clinton County is using wireless to connect 30 homes as part of a US Ignite project OVERCOME effort.

The NTIA should look for spectrum allocated to federal agencies that's needed for their longer-term missions but isn't needed for the next few years. That spectrum is needed for the wireless quick wins, but can be returned to the federal agencies at a time certain, or dynamically via spectrum allocation services such as is being used with CBRS. This may include lower spectrum bands which have limited data rates but are nevertheless better than nothing for those who are presently unconnected. The limited time offering for this quick win will build a customer base which can, in a few years, be an attractive target for a commercial provider willing to provide fiber-based services or fiber-to-small-cell offerings in that area.

Unlicensed spectrum for point-to-point backhaul should continue to be made available by the FCC in higher frequency bands to facilitate wireless backhaul and may also be available via NTIA temporary allocation.

Success Metrics

We all know that we best achieve that which we can measure. A consistent set of "success metrics" across all funded projects will help provide continuing national attention on the size of the "connecting the unconnected/underserved" problem and the progress being made and will help generate press and other attention to support the program and its potential expansion, if necessary, to reach remaining Americans. US Ignite is doing this in its Project OVERCOME. We need to keep the success metrics topic in front of the press and the public consciousness and emphasize the nonprofit/academic/state/private collaborations that work so successfully, and well as the future transitions to competitive providers over neutral infrastructure that will be a permanent communications infrastructure competitive advantage for the United States.