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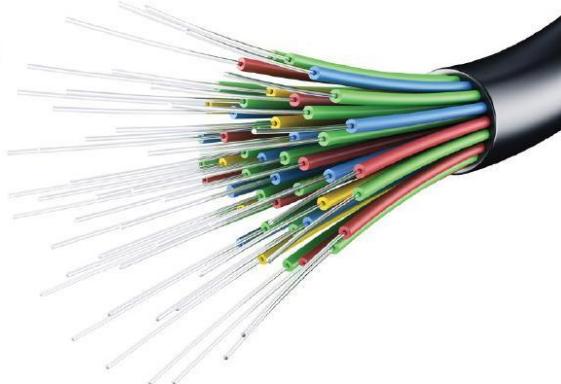
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In the hills of southwestern Wisconsin, atop grain elevators and silos, a small team of technicians is assembling a next-generation wireless 5G network piece by piece. They work for a rural broadband company, not a telecom giant, and their mission is bringing connectivity to homes that otherwise wouldn't have it, rather than helping people max out the speeds on their new \$1,000 phones.

David Bangert, the 51-year-old founder of [WiConnect Wireless](#), still lives on the farm where he grew up, just outside of Ithaca, Wis. His company has nine employees and serves broadband internet to 1,400 rural households in seven counties. The "wireless" in the name isn't referring to cellphones, but to the way he's connected homes to the internet for the past 14 years. He's depended on a variety of wireless technologies, including miles-long relays of Wi-Fi base stations.

Now, with 5G, there's a convergence of cheaper hardware, free and open-source software, and lightly regulated wireless spectrum free for most anyone to use. It's enabling WiConnect to reach new customers and offer connection speeds rarely seen on rural Wisconsin's side of the [digital divide](#). Though its performance might seem underwhelming to urbanites who live with ultrafast fiber-optic broadband, the technology WiConnect is using is remarkably similar to what is already enabling 5G networks in the world's most advanced and automated factories, warehouses, ports, mines and military bases.

Players large and small are now building specially designed private 5G networks. In contrast with the 5G networks [celebrated during the launch of the latest iPhone](#), these are intended as much for machines as people. Private networks are geographically constrained areas of coverage, intended to keep a

after 2018 widened  
mail-in option

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vote while  
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**Pittsburgh Tribune-  
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and Santorum are  
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Editorial: The  
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Editorial:  
Pennsylvanians, a  
keystone in this  
election, can  
continue to lead the  
way

local set of sensors, machines and computers in sync, and allow communications with the rest of the world as needed.

Utility companies, retailers and other large enterprises have in the past made use of private 4G cellular networks. These can be more customizable than a carrier's existing network, and offer better reliability and security than Wi-Fi, especially over large areas. With 5G, it's suddenly possible for many companies—even rural broadband providers—to bypass the traditional network gatekeepers and create their own 5G wireless networks, with more bandwidth than ever. "In this world it's kind of like feeding the beast: always more more more, gotta have more," says Mr. Bangert. "As everybody transitions to streaming video, online meetings, online school, every device connected and all-consuming bandwidth, what used to be just fine is now limiting, and I don't see that changing."

Private 5G networks are like your home Wi-Fi, except instead of a router, they use radios called cell sites, each with a range of a mile or more outdoors. Like a Wi-Fi router, a cell site must be tied to the internet through a physical cable, or wirelessly, through another cell site. One big difference is the software running the system. In a cellular system, all the traffic is tightly controlled and centrally organized, giving every connection enhanced speed and reliability.

Traditionally, the software that runs these 5G networks was written by the companies selling their hardware, including giants like Nokia, Ericsson and Huawei. But in February 2019, engineers at Facebook open-sourced Magma, software that anyone could use as the operating system, or core, of their own network. Another critical element of a cell network is spectrum, the range of radio frequencies participating devices must keep to. The carriers have, over the years, paid billions in government auctions for exclusive access to wireless spectrum. But now there's a slice that isn't entirely under their control.

The Federal Communications Commission recently opened up a patch of mid-band spectrum known as the Citizens Broadband Radio Service. Some of the CBRS band is available to anyone who wants to register for it, as long as they specify where and how they want to use it for their own network. The last time a chunk of spectrum was made this accessible by the U.S. government was in 2003, when more airwaves in the 5 gigahertz range were freed up for Wi-Fi. All in, a company or individual can now set up their own single-site 5G network for less than \$5,000, says Boris Renski, chief executive and founder of FreedomFi, which sells a version of the open-source Magma software to customers such as Mr. Bangert's WiConnect.

In a December 2019 report, analysts at Deloitte predicted that by the end of 2020, more than 100 companies world-wide will have begun testing their own private 5G networks. That includes organizations such as Ford Motor Co., Corning Inc., BMW AG, BASF SE, China's state-owned Shandong Energy Group, and the U.S. military, which by itself is pouring \$600 million into five different projects.

Even though companies can build their own private 5G networks, they can also pay wireless giants to do it for them, says Sowmyanarayanan Sampath, president of global enterprise at Verizon Business. The advantages include network-building know-how, regular monitoring and repair, he adds. Plus, when companies hire a wireless giant, they can gain access to all the extra 5G spectrum that carrier has rights to. In March, The Wall Street Journal reported Verizon was in talks with Walmart to set up 5G networks to connect its stores.

For the most part we're still waiting for applications for the kind of consumer 5G being rolled out by the world's biggest carriers, but private 5G is already proving useful, says Kevin Westcott, head of the U.S. technology, media and telecommunications practice at Deloitte. The fast speeds and ability of mid-band 5G wireless signal to go through trees and other obstacles mean companies can use it for mundane but important tasks like connecting to

machines without running cables to them. Other applications include, for example, connecting and tracking equipment such as forklifts and cranes in ports [in China](#).

Companies are adopting more robots and automation [in factories and warehouses](#), and as these devices become more autonomous and reliant on artificial intelligence, there's a need for ultrafast connections between these robots and the computers inside the same buildings, to help them [make sense of their surroundings](#). Robots that rely on remote computers to process what they are seeing, and tell them how to react from one millisecond to the next, need low latency—the lag between when a signal is sent and when it arrives somewhere else in a network. The way 5G radios behave gives them lower latency and greater reliability than any other wireless option, says Rajeev Shah, chief executive and co-founder of [Celona](#). His Cupertino, Calif.-based startup is now piloting 5G and 4G LTE private networks with more than 30 different companies and schools.

Paradoxically, 5G is so fast, the internet itself can be a bottleneck. If robots, sensors and other devices are to communicate without delays, they need to connect to computers on the premises, not in the cloud, says Mr. Westcott. For many of the world's largest multinationals, the goal of rolling out 5G is making their operations more automated and efficient, a process some call [the fourth industrial revolution](#). In rural Wisconsin, Mr. Bangert's goals are more modest.

Every new 5G site Mr. Bangert can put up, for about \$20,000 apiece, connects on average 25 more homes, he says. Grain silos are optimal places to put sites: They're tall, they already have power, and most of the farmers who own them are begging him to bring faster internet service to their land. WiConnect's home 5G has average speeds of 25 megabits per second download and 5 Mbps up—a far cry from the 100 Mbps or more that can be had in major U.S. population centers. And even though WiConnect is using essentially free bandwidth, the service still costs \$79 to \$99 a month. That's the cost of broadband going where no broadband has gone before. — *Wall Street Journal*

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One of out five consumers are fine with just having some combination of Netflix, Amazon Prime Video, Disney+ or any other SVOD platform as their viewing option at home, according to a new survey from the Leichtman Research Group.

The survey found that 20% of U.S. TV households have a SVOD service but no pay-TV subscription. However, a majority (60%) still do subscribe to both a pay-TV and SVOD service. Only 14% said that they only had a pay-TV service, while just 6% said they had neither pay-TV or SVOD. Just under three-fourths of households (74%) get a live pay-TV service, be it cable, DBS, telco or an vMVPD. That is down from responses in 2015 (85%), 2010 (88%) and 2005 (82%). Among those with a pay-TV service (cable, telco, DBS), 79% have an SVOD service; if they have an vMVPD that number jumps to 96%. About 76% of pay-TV non-subscribers have an SVOD.

SVOD isn't the only way people are watching content if they don't have pay-TV, as LRG reports that 13% of pay-TV non-subscribers utilize a TV antenna. The older a respondent was the more likely they were to have a pay-TV subscription: 81% for 55 year olds and older; 76% of ages 35-54; and 63% of ages 18-34. With the youngest age bracket, 27% said they had both a pay-TV service and SVOD, while 46% said they just had an SVOD.

"Traditional pay-TV services from cable, satellite and telco providers are now in less than two-thirds of U.S. households, while an increasing number of households are opting to get live pay-TV from internet-delivered vMVPD services," said [Bruce Leichtman, president and principal analyst for LRG and popular Cable Academy presenter](#). "Consumers continue to choose the video services that best fit their household needs. For 60% of households, this includes both pay-TV and SVOD services."

Additional findings from LRG's report include how 38% of those who moved in the last year do not currently have a pay-TV service, higher than any previous year. Also, 33% of pay-TV non-subscribers had a pay-TV service within the last three years, 34% last subscribed more than three years ago and 33% never had a pay-TV service. – **TVTechnology**

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State lawmakers return to Harrisburg on Tuesday for the start of what has become a rarity in recent years with a post-election session in which substantive legislation is expected to be considered. That action primarily involves trying to complete work on the 2020-21 state budget. While the annual state budgets usually are completed in the summer, the coronavirus pandemic changed those plans.

State lawmakers and Gov. Tom Wolf approved a budget to fund most programs through Nov. 30; schools have been funded through June 30. The Republican-led General Assembly and the Democratic governor will need to strike an agreement to pay for some essential state services. Some suspect though there also could be movement on some non-controversial bills that passed one chamber but were in the final stages of getting through the other prior to the election break.

But it kicks off on Tuesday with the biennial exercise of holding caucus leadership elections. This year, those will produce some changes due to legislators' retirements in both chambers. Among others, the departure of Senate President Pro Tempore Joe Scarnati, R-Jefferson County, creates an opening in the Senate's top post. Potentially, there could be a new House Democratic leader. Rep. Frank Dermody's vote totals were lagging behind his Republican challenger Carrie Delrosso for that Allegheny County House seat as late as Friday afternoon.

But no one anticipates this upcoming lame-duck session will be a time of political mischief although past post-election sessions have been ripe for that because it is a time when lawmakers are least accountable to voters. The [Senate put a stop to them in 2008](#) when they made the decision to not take up any legislative business after Election Day and stuck by that ever since. The House followed suit in 2012.

But this year is different because of how the state budget was dealt with due to the pandemic. In late May, the Legislature passed a \$25.8 billion general fund budget that funded most of state government operations through the end of November. It did, however, include a full-year's funding at last year's level in many of the public school budget lines, as well as state-supported universities, debt service and school pension obligations.

Lawmakers chose to go with an interim budget last spring in hopes that by waiting to finalize the budget in the fall, the extra time would bring more clarity to the state's revenue picture. The decision to push back the April 15 deadline for filing personal income tax returns to July 15 - due to the COVID-19 pandemic - made it difficult to forecast what that revenue stream would produce.

Additionally, they wanted to see if Congress would provide some stimulus funding to help state governments balance their budgets. State lawmakers are still anxious to see if more help is coming from Washington. Lyndsay Kensinger, a spokeswoman for the governor, noted the urgency to get a budget deal done by the end of the month. "The administration is working with the General Assembly to complete a balanced budget by the end of November," said Kensinger. "We expect discussions to begin in earnest soon and our goal is to settle on a level-funded budget with additional allocations necessary for mandated programs. It is critical for us to finalize the budget by November to avoid furloughs and any stoppage of critical payments to providers and grantees."

She said the administration continues to have a freeze on hiring and is making efforts to reduce spending wherever possible. Republicans share that desire to get Budget Part 2 done by the end of the month, but they also are insisting it be accomplished without a tax increase of any sort. Instead, sources suggest they expect the \$8.3 billion needed to fund government operations at last year's level will come from a variety of sources, many of which are already or expected to be in hand.

That includes some or all of the \$1.3 billion in unspent federal CARES Act money that the state received. However, Wolf and Democrats have proposed other ideas for using that money to help individuals and small businesses recover from the pandemic's impact. The 2020-21 state revenue performance has been better than expected, so far, which certainly helps. The [state's Independent Fiscal Office](#) last month revised its projected revenue forecast upward by \$650 million (roughly 1.8% higher) from its June estimate for a total of \$36.5 billion.

Enhancements in the federal match for medical assistance, coupled with an increased number of Pennsylvanians eligible for this aid due to pandemic-related unemployment and the state's rapidly aging population, could produce upwards of \$1 billion to help fund the remaining needs for that line in the Department of Human Services budget. Other patches are likely to come from transfers from special funds outside the general fund along with the potential for some type of borrowing.

What could complicate getting a budget done is if there is any spillover from the Republicans' strained relationship with Wolf over his handling of the pandemic. More recently, lawmakers have expressed some concerns about the administration of this election that brought bigger GOP majorities to both legislative chambers.

Senate GOP Leader Jake Corman, R-Centre County, and Senate President Pro Tempore Joe Scarnati, R-Jefferson County, called for Secretary of the Commonwealth [Kathy Boockvar's resignation](#) over their concerns about election administration guidance she provided to counties. Boockvar said she had no intention of resigning and Wolf defended her and accused the Republicans of trying to "undermine confidence in the results of the election."

In the House, House GOP spokesman Jason Gottesman said Republican leaders have tried since June to open up communications with the governor and his staff with little success. "We hope that the fact we need to get this budget done that they will come around to understanding the benefit of working with the Republican General Assembly because they are going to have that for the remainder of their term," he said. — [Pennlive](#)

