

EXPERT EDITION

5G: The Future of Government Connectivity



INSIGHTS FROM

- Agricultural Research Service
- DoD
- DHS Science and Technology
- NSF
- Veterans Affairs

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Feds focus on tapping the future potential of 5G

In programs across government, federal network chiefs and research teams are working to unlock the potential of 5G mobile wireless.

The Agricultural Research Service, for instance, is looking at how to use 5G wireless networks and unmanned aircraft vehicles as “next-generation geographic information systems,” says Mike Buser, national program leader for engineering, natural resources and sustainable agricultural systems at the Agriculture Department agency. UAVs are already helping researchers measure and analyze key factors like soil erosion, crop yield and pollinators.

At the Defense and the Homeland Security departments, teams want to figure out how to tap 5G to overcome communications challenges that plague incidents demanding a sudden influx of first responders. While access to a speedy and reliable comm platform is critical, securing first responder networks also remains essential.

“We have a need to roll this out in a responsible manner to make sure it’s secure, safe, available, and we can extract the goodness of these technologies without exposing ourselves to vulnerabilities and risk,” explains Sridhar Kowdley, program manager for communications and networking technologies in DHS’ Science and Technology Directorate.

The Veterans Affairs Department so believes in the increased benefits of 5G for telehealth and other medical needs that it’s been studying how to bring its exploratory 5G pilots into VA operational networks. In addition to 5G, the department is also “exploring and expanding our footprint around software-defined wide area networks,” says Daniel Mesimer, director of network engineering at VA.

Meanwhile, the National Science Foundation also has a massive R&D effort under way that involves a series of city-scale test beds that will provide it the chance to test innovative 5G use cases.

In the pages ahead, you will be able to find out more about each of these efforts and glean learnings that can help your organization as it implements 5G.

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Agricultural Research Service looks to precision technology, data to boost farming and ranching

BY JUSTIN DOUBLEDAY

With the global population expected to reach 9 billion by 2050, the Agriculture Department's research arm is turning to new technologies and data analysis to make crop production and other forms of farming less costly and more efficient.



But as so-called precision agriculture advances, the new technologies are running into an age-old problem: How do you convince users to adopt them?

"The reality is, when you look at the vast majority of our farmers, ranchers and processors out there, they're really not using these technologies," said Mike Buser, national program leader for engineering, natural resources and sustainable agricultural systems at the Agricultural Research Service, whose USDA team grapples with the issue every day. "Part of that is an education piece."

"We often get into discussions about how many of these computations we really need to be doing locally."

— Mike Buser, National Program Leader for Engineering, Natural Resources and Sustainable Agricultural Systems, Agricultural Research Service

Precision agriculture refers to a range of sensors and systems that automate different tasks across farming and ranching. Examples include systems that can identify and spray weeds in fields.

Tractor guidance systems are being developed to more accurately plant crops, spray herbicide and apply fertilizers.

USDA focuses on gaining technology acceptance

Buser's team has spent a lot of time in recent years working on how they communicate about technology with farmers and ranchers. A key effort is Partnerships for Data Innovations, he said.

"It's really focused on pulling data from all of our research data silos out across the country and pulling them back into a common cloud-based platform," Buser said.

It helps that farmers and ranchers are generally more willing to share data with researchers than they were a decade ago. The information helps ARS researchers fine-tune new systems and gather more complete data sets, while they can also help farmers and other consumers get the most out of the equipment, Buser said.

"If we're able to do that, it really takes us to the next level," he said. First, ARS can help producers get value out of precision agriculture technology that they invested in. Second, it helps ARS researchers and engineers identify possible failure points or things

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— Agricultural Research Service’s
Mike Buser

that people don’t like because they’re not user-friendly or functional. Those types of things can lead users “to bypass the entire system,” Buser said.

On the precision agriculture horizon

ARS also is looking to use 5G wireless networks and unmanned aircraft vehicles as “next-generation geographic information systems,” Buser said. UAVs are helping researchers measure and analyze key factors like soil erosion, crop yield and pollinators.

USDA also works with the Federal Communications Commission through the Precision Ag Connectivity Task Force. The group provides advice and recommendations for FCC on deploying broadband internet on unserved agriculture land and promoting precision agriculture.

A recent report from the task force recommended FCC and USDA collaborate and share public-facing data sets to develop broadband availability maps “that reflect and confirm the unserved and underserved areas on agricultural lands.” 

What’s the right cloud approach for precision agriculture?

While the Agricultural Research Service studies how to take better advantage of interconnected technologies and 5G, it’s also looking at how much data needs to be transmitted back to cloud computing centers.

“We often get into discussions about how many of these computations we really need to be doing locally,” said Mike Buser, national program leader for engineering, natural resources and sustainable agricultural systems at ARS.

Advances in microchip technology mean more data can be processed onboard sensors. Buser gave the example of a cotton production system that can glean information about the quality and moisture content of cotton as it’s being harvested.

The information could be packaged into a module in the field and then transmitted to a cotton gin, which can use the analysis to ensure the cotton isn’t dried for too long, resulting in a less valuable product.

“I think the answer there is that it really depends on the production system, how much data we actually relay and transfer, and what does that ultimately result in — in terms of value,” Buser said.

Homeland Security's Science and Technology Directorate works through challenges of 5G adoption with first responders

BY JUSTIN DOUBLEDAY

The Homeland Security Department's Science and Technology Directorate wants to help first responders realize the potential benefits of 5G wireless communications and avoid the challenges associated with relying on more interconnected, digital technologies.



"We have a need to roll this out in a responsible manner to make sure it's secure, safe, available, and we can extract the goodness of these technologies without exposing ourselves to vulnerabilities and risk," Kowdley said in an interview.

There's an imperative to roll out 5G responsibly, whether it's working with DHS subcomponents like Customs and Border Protection or local first responders, said Sridhar Kowdley, program manager for communications and networking technologies in the S&T Directorate.

Using 5G as a launch pad for AR/VR at Homeland Security

With 5G offering big increases in bandwidth along with reduced latency, Kowdley said S&T is examining its potential for augmented reality and virtual reality training, as well as the "massive integration of devices and sensors."

But as the directorate rolls out additional capabilities to first responders, Kowdley said a key question is how more data and connections can offer benefits without hampering the mission.

He offered the example of Next Generation 911. Many states and localities are already transitioning to the new Internet Protocol-based systems, which can accept not just voice calls but photos, videos and text messages.

"What we can't have is every jurisdiction go off on their own and not have access to all the data that could potentially be available."

— Sridhar Kowdley, Program Manager for Communications and Networking Technologies, Science and Technology

“The telecommunicators that handle calls, they’re basically traumatized with handling calls to begin with, but now imagine they’re getting video and text and images and multimedia feeds,” Kowdley said.

“We also need AI at that edge to start looking at it and processing it. Can we extract metadata and only give them the bare minimum or deliver the video content in a very concise and efficient manner so that it doesn’t overwhelm them or overload them?”

S&T is working on that issue with the Transportation Department, he said.

DHS partners with NASA and CISA on first responder tools

The directorate also partnered with NASA’s Jet Propulsion Laboratory to develop an AI application called the Assistant for Understanding Data Through Reasoning, Extraction and Synthesis, or AUDREY. It helps deliver relevant data to first responders depending on the emergency scenario.

For instance, Kowdley explained, “it would learn that, ‘Oh, you’re a fire, so I don’t need a person of interest. I’m more worried about other chemical devices that are triggered. ... Where are the exit points?’ ”

One of S&T’s other key partners is the department’s Cybersecurity and Infrastructure Security Agency, Kowdley said. The directorate is working in tandem with CISA to solve for security and resiliency issues in 5G networks, where more devices and data can yield a larger attack surface.


S&T also plans to work with CISA and other partners to test out the response to a distributed denial-of-service attack on first responder communications and other commercial technologies.


“We have a need to roll this out in a responsible manner to make sure it’s secure, safe, available, and we can extract the goodness of these technologies without exposing ourselves to vulnerabilities and risk.”

– DHS’ Sridhar Kowdley

“We’re bringing in a whole bunch of responders to say, ‘OK, how do you make yourself more resilient?’” he said. “Whatever we learn will not only help during interference situations but also in general situations. Like, how do you build resiliency for a Super Bowl event? You have to develop your primary and alternative contingency and emergency plans. So we’re sort of educating them. And we’ve partnered with CISA to do that.”

With organizations from different jurisdictions bringing an increasing amount of devices and sensors to emergency scenarios, Kowdley is also keenly focused on interoperability. DHS put out an integration handbook recently to provide guidance about how to develop technologies using common standards.

“What we can’t have is every jurisdiction go off on their own and not have access to all the data that could potentially be available,” he said. “So interoperability and compatibility are going to be key moving forward, leveraging existing assets for efficiencies and deployment scenarios. Those are all key drivers for DHS S&T.” 



VA looks to boost healthcare services through wireless experiments

BY JUSTIN DOUBLEDAY

The Veterans Affairs Department is experimenting with 5G mobile networks at three medical centers, while also using the wireless networking technology to boost connections at rural locations.

The department has a multipart strategy for modernizing its networks, with a big emphasis on looking for alternative forms of transport, said Daniel Mesimer, director of network engineering at VA.

“That’s where conversations around cellular 5G come into play,” he said. “We’re also exploring and expanding our footprint around software-defined wide area networks (SD-WANs),” he said. “We really see the marriage of those two providing some additional services and support for our clinicians, our service providers and, at the end of the day, for our veterans.”

In recent years the department has launched three 5G experiments at medical centers in Palo Alto, Seattle



and Miami, respectively. The experiments are all in their early stages, Mesimer said. “We see that as a launching point for us to engage with our innovations teams to really explore what those use cases are and how we fold the 5G capabilities into the VA network infrastructure,” he said.

Figuring out when to bring 5G into operational networks

Eventually, VA wants to combine the experimental 5G networks with the operational networks at each medical center to provide staff and patients with high-speed, low-latency data connections. “They would experience a better application experience – faster access to the telehealth systems, easier access to some data sets and the data centers,” Mesimer said.

VA currently is working through challenges with combining the experimental 5G networks with the department’s secure production network.


“There’s a bit of a methodical approach as we go through these things,” he said. “Tying back to the fact that today we have a distinct split between our test environments and our production environments, so that we can roll through test scenarios of the applications as well as their security impact before considering rolling them into production.”

In addition to exploring new applications like smart medical devices and augmented reality healthcare, VA also wants to use 5G to boost connectivity in rural settings, where wireless connectivity is typically reduced.

“We’re doing our best to provide modern telehealth services not only to our providers but to the veterans in those areas,” Mesimer said. “The rural coverage has been an ongoing challenge.”

VA taps 5G to improve network experience

Recently, Mesimer said his team helped support site activations in rural California by combining 5G networks with SD-WANs, using 5G as the wireless backhaul network.

“We did realize lower latency. We realized reduced jitter. We did see the increased bandwidth compared to its LTE and 4G counterparts, and that was very successful,” he said. “We did bump our knees a bit on some of the early adoption issues where some of the carrier networks are continuing to expand and support. We stubbed our toes a couple of times there. We found the need for some very distinct site surveys so that we can get antennas aligned correctly and items like that.” 

“We really see the marriage of [5G and SD-WANs] providing some additional services and support for our clinicians, our service providers and, at the end of the day, for our veterans.”

— Daniel Mesimer, Director of Network Engineering, Veterans Affairs Department



National Science Foundation brings ‘city-scale’ wireless test beds to life

BY JUSTIN DOUBLEDAY

The National Science Foundation is nearly done deploying four “city-scale” wireless test beds at locations across the country, giving researchers a chance to study radio-frequency challenges relevant to many federal agencies.



The NSF Platforms for Advanced Wireless Research (PAWR) program has projects underway in four cities: Ames, Iowa; New York City; Raleigh, North Carolina; and Salt Lake City.

Researchers intend to use the flexibility of the test beds to research new concepts using existing systems, said Murat Turlock, program director in NSF’s Computer and Network Systems Division. The test beds are fully programmable and can be reconfigured according to researcher need.

It has completed deployment of the Cloud Enhanced Open Software-Defined Mobile Wireless Testbed, or COSMOS, in New York. COSMOS covers one-square mile in West Harlem, where the technical focus is on “ultra-high bandwidth and low-latency wireless communications, with tightly coupled edge computing, a type of cloud computing enabling data processing at the edge of the network.”

“When you look at the problems in wireless, it’s almost similar to designing a next generation of a computer chip using the computers built with existing chips,” Turlock said.

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— Murat Turlock, Program Director, Computer and Network Systems Division, National Science Foundation

In Salt Lake City, NSF has deployed the aptly named POWDER test bed, which stands for Platform for Open Wireless Data-Driven Experimental Research. The technical focus in Salt Lake is broad, covering areas like 5G wireless networking, Radio Access Network (RAN) architectures, network orchestration models and massive multiple-input, multiple-output (MIMO) networking.

NC experimental network focuses on airspace connectivity

More recently, NSF and its partners finished setting up the Aerial Experimentation and Research Platform for Advanced Wireless platform, or AERPAW, just outside Raleigh. NSF describes AERPAW as a first-of-its-kind experimentation platform aimed at speeding up the integration of unmanned aircraft systems (UASs) into the national airspace.

Researchers there are also looking to test out the potential of using UASs for wireless connectivity, such as flying base stations that can provide an aerial hot spot.

Meanwhile, in Iowa, the PAWR program is in the process of deploying the ARA platform. ARA stands for “Agriculture and Rural Communities” and it aims to test wireless connectivity in a rural setting, especially with use cases like precision agriculture.

Pushing the wireless envelope at NSF test beds

At the COSMOS test bed in New York, researchers are testing the best way to deploy a millimeter-wave network in a dense, urban environment.

“They have to understand how the signal propagates through air or buildings,” Turlock said. “That understanding will allow the designers to come up


“The spectrum is a natural resource. So we have to, as a nation, we have to probably learn how to best leverage this resource.”

— NSF’s Murat Turlock

with better designs and provide services that may not have been available before: very-high-speed internet access, availability of the connection in different locations inside the buildings or outside of the buildings. So there’s lots of scenarios that the researchers sort of have to understand and feed into the design process.”

The PAWR program is backed by approximately \$100 million in funding, with contributions from both NSF and an industry consortium of about 30 companies. The test beds are collocated with local universities. And Turlock said other agencies have gotten involved in research at the test beds as well, including the Defense Department.

In North Carolina, the AERPAW test bed is giving researchers the chance to test out a national radio dynamic zone concept that will allow different users of the electromagnetic spectrum to “peacefully coexist,” Turlock said. The issue of spectrum management is becoming increasingly important as more users seek access to similar or the same radio frequencies.

“The spectrum is a natural resource,” Turlock said. “So we have to, as a nation, we have to probably learn how to best leverage this resource.” 

Agencies look toward new emergency networks when disaster strikes

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Mark McDiarmid,
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for Radio Network
Engineering and
Development, T-Mobile

5G wireless networks are expected to provide a leap in performance above legacy 4G communications, but first responders can still face the prospect of congested and unavailable

communications networks during a natural disaster.

Agencies are eyeing a range of possibilities to take advantage of 5G, but perhaps no application is more urgent than ensuring and even boosting connectivity to aide disaster response.

In October 2021, the Defense Department announced it would begin prototyping a private 5G communications network for first responders in California, where firefighters, the National Guard and others have been battling historic wildfires in recent years.

Disaster management requires cross-agency response

The Department of Homeland Security's Science and Technology Directorate is also developing secure and resilient emergency mobile networks for first responders in conjunction with the Cybersecurity and Infrastructure Security Agency.

Disaster response is among the areas where wireless companies are getting the most interest from agencies, said Mark McDiarmid, senior vice president for radio network engineering and development for T-Mobile.

"We've been working very closely with government agencies on research and development projects to figure out how to bring relief coverage into areas that have been possibly devastated by high winds," McDiarmid said. "One of the challenges of wireless technologies is wind doesn't mix very well with antenna structures."

Agencies are looking at drones as one possible solution when traditional networks go down. "We're collaborating

with the U.S. government on new forms of drone-based coverage where we can fly base stations several hundred feet above ground and power them for many tens of days to provide relief coverage,” he explained.

A 5G drone fleet? Maybe

Agencies are also looking to use 5G to bolster their drone operations, which rely on wireless connections. That includes an increasing reliance on drones to provide better situational awareness, McDiarmid said.

Drones appeal to many government agencies because they can use them to extend their teams, he said. Some common examples include using drones to survey large areas or to assist in search and rescue. Increasingly, government agencies are planning or launching proof of concepts involving 5G drone capabilities and testing how they can deploy them into their operations, McDiarmid said.

How are cities investing in 5G to get smarter?

Find out in this Federal News Network article, [“3 tips for becoming a smart \(or smarter\) city in the age of 5G”](#)

“Through mechanisms in 4G and 5G, we can prioritize access and bandwidth in such a way that wireless priority service can be given to first responders.”

— T-Mobile’s Mark McDiarmid

Local networks also see massive increases in traffic during emergencies, which can lead to congestion for first responders trying to communicate and coordinate their activities. But wireless networks can now be configured to give responding personnel the top priority when it comes to routing traffic during an emergency.

“Through mechanisms in 4G and 5G, we can prioritize access and bandwidth in such a way that wireless priority service can be given to first responders,” McDiarmid said. 📶