Shaping the Future

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Texas A&M technology helps electric providers detect faults, prevent wildfires

When your power goes out, you probably assume that your utility provider has a monitoring system quickly telling them exactly where the problem is. After all, this is the era of smart technology and big data.

But the electric grid wasn't designed or built in this era. Utility companies may know if there is an outage, but they likely don't know exactly where or what the problem is until crews inspect it and find the problem. Utility providers are essentially blind to developing problems in the grid other than whether the power is on or off.

Not only is their ability to assess a current outage limited, they also have no way of identifying a problem that may not actually be causing an outage or anticipating where a problem may occur in the future. For example, a failing device could be sparking, creating a dangerous situation that nobody is aware of for days or weeks before it completely fails and causes an outage.

But, not anymore.

Applying concepts of pattern recognition and advanced signal processing to more than a decade of data, a team of Texas A&M University researchers

RESEARCHER

Dr. B. Don Russell
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has developed a new technology called Distribution Fault Anticipation (DFA). It has the capability to not only help utility providers find the cause of outages, but to also anticipate and predict some failures before outages occur. (Their published research, Application of DFA

Technology for Improved Reliability and Operations, was presented at the 2017 Institute of Electrical and Electronics Engineers Rural Electric Power Conference in Columbus, Ohio.)

"Power distribution system electrical signals include specific failure signatures, which tell a story — for instance whether potential faults and outages are about to occur," said Dr. B. Don Russell, a power engineer and the Engineering Research Chair Professor and Distinguished Professor in the Department of Electrical and Computer Engineering at Texas A&M.

Simply put, they've been 'listening' to the electric grid for more than a decade to analyze signals and identify which ones indicate a potential problem. Conceptually, it is not much different from an auto mechanic who can hear a problem in an old engine and know exactly what is causing it. Practically, however, this is an entirely new technology.

The Texas A&M research team led by Russell includes Carl Benner, Jeff Wischkaemper and Karthick Manivannan. Their research, sponsored by the Electric Power Research Institute, developed the DFA technology. It is an autonomous, distributed computing system that provides electric utility operators a continuous situational awareness of the condition of each circuit. The result is increased reliability of their network and reduced outages. It enables the utility operator to predict adverse power line conditions and events generally not detected by conventional technologies.

"DFA recognizes the impending failure mechanisms of most distribution hardware, often allowing operators to find and fix failing devices before catastrophic failure," said Russell. "The devices report line events to a master station server, which provides access to reports from a fleet of DFA devices on circuits across the power system."

An obvious example of the benefits from this technology is wildfire prevention. High winds can cause electric lines to contact, causing arcing on the line and damaging it, but not causing a complete outage. The sparks from these faults have been known to start wildfires, especially during dry conditions and often without the knowledge of utility personnel. Repeated contact can burn the line down. DFA has also helped utilities detect and locate tree branches making contact with power lines and causing faults, which can start fires directly or break a line and cause it to fall to the ground.

An example of this situation was the devastating fire of 2011 in Bastrop, Texas, where a true worst-case scenario unfolded when high winds and severe drought conditions caused the most damaging wildfire in Texas history. Many wildfires in the western United States last year were also linked to electric faults.

Russell explained that awareness of adverse events and conditions, even before they cause a failure, enables utility companies to take preventive action by performing repairs or condition-based maintenance. The DFA technology is a result of more than 15 years of continuous research collaboration, resulting in the only system of its kind.

"A practical benefit of using DFA is the ability to detect and repair arcing and misoperating devices that often cause wildfires," said Russell. "In a four-year study just completed at Texas A&M, it has been proven that many fires can be prevented with this technology. Whether preventing wildfires or dangerous power lines on the ground, DFA is the new tool that improves reliability and safety."

Industry Tested

This technology is not just lab tested, it is field proven as well.

Robert Peterson, director of control center and emergency preparedness at Pedernales Electric Cooperative, the nation's largest distribution electric cooperative, said DFA has been invaluable in providing information that is not available any other way.

"DFA has enabled us to identify potential issues like trees on lines, failing clamps, failing arrestors, etc. and resolve

those issues before they create power interruptions," he said. "In one case, we were able to pinpoint the location of a branch on an overhead line that could have become an ignition source for wildfire in a rural subdivision. We have also used the monitors to provide information allowing us to proactively address issues with capacitor switches in order to keep our power factor within regulatory prescribed limits. Overall, the technology has proven itself to the extent that our plans now include expanding their use to the rest of our distribution system."

Dr. Comfort Manyame, senior manager of research and technical strategy, and Robert Taylor, engineering specialist, at Mid-South Synergy were also complimentary of the technology. Taylor said, "It makes me wonder what we did before DFA," while Manyame said they are hoping to expand their use of DFA in the coming years.

"DFA has so far been the single most important operational technology we have implemented which has given us

wins in the shortest amount of time," Manyame said. "We want to multiply our DFA benefits and improve our overall system reliability and resilience by expanding our installation, possibly to our whole system, in the next few years."

Thomas Ellis, manager of engineering at Bluebonnet Electric Cooperative, said that their control center operators have used DFA information to accurately determine the cause and location of multiple faults, including a fault that affected just one single customer on a stretch of circuit with more than 160 miles of overhead line.

"We would have been unaware of this issue until a member reported an outage, which did not happen for a full hour," Ellis said. "A crew was already en route, with the information that the likely cause was a failed arrester, before we even got the call from the affected location."

According to Ellis, information provided by DFA "allows us to better identify intermittent faults, incipient failures and capacitor malfunctions. Increased prefailure awareness facilitates proactive

equipment repair to mitigate catastrophic failures and avoid sustained outages."

He added that DFA technology not only improves customer satisfaction, but also improves worker safety, thanks to diagnostic capability of the system leading to more efficient troubleshooting.

That kind of industry feedback makes all of the efforts by DFA creators worth it according to Benner, an engineer, co-inventor and associate research professor in the electrical and computer engineering department.

"We have spent 20 years developing DFA," Benner said. "I get great personal satisfaction when I see utility companies using it on a day-to-day basis to improve their operations and the quality of service they provide to their customers."

This research is funded by the Texas A&M Engineering Experiment Station and the Texas Wildfire Mitigation Project, which was initially established by the Texas State Legislature in 2013, with the support of the Texas A&M Forest Service.

TEES

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