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Meeting today's reliability challenges with tomorrow's line sensor technology

By Swarnab Banerjee

Old power grid equipment, major storms and an aging workforce are just some of the challenges electric utilities face in today's ever-changing energy landscape. If not managed well, these challenges lead to a much bigger problem: power outages that cost utilities' customers millions of dollars by interrupting critical operations.

Electric utilities can cope with the risk of future service outages in various ways, including modernizing distribution networks, managing foliage growth and hiring more line repair crews. These options can be complex to evaluate, however, because all have varying degrees of cost, technical risk and societal benefits.

A recent focus for many utilities has been locating, hiring and training more line repair personnel, because it improves outage response and results in better service for customers. In many parts of the world, however, the aging workforce makes it increasingly difficult to find skilled labor and fill vacant line crew positions. What if it were possible to improve the line crew's work activities so that they can allocate more time to actual repair and high priority maintenance and spend less time searching for broken wires?

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Capturing Data at Power Grid Nodes is Key

In recent years, many countries have experienced prolonged power outages simply because locating the

Figure 1

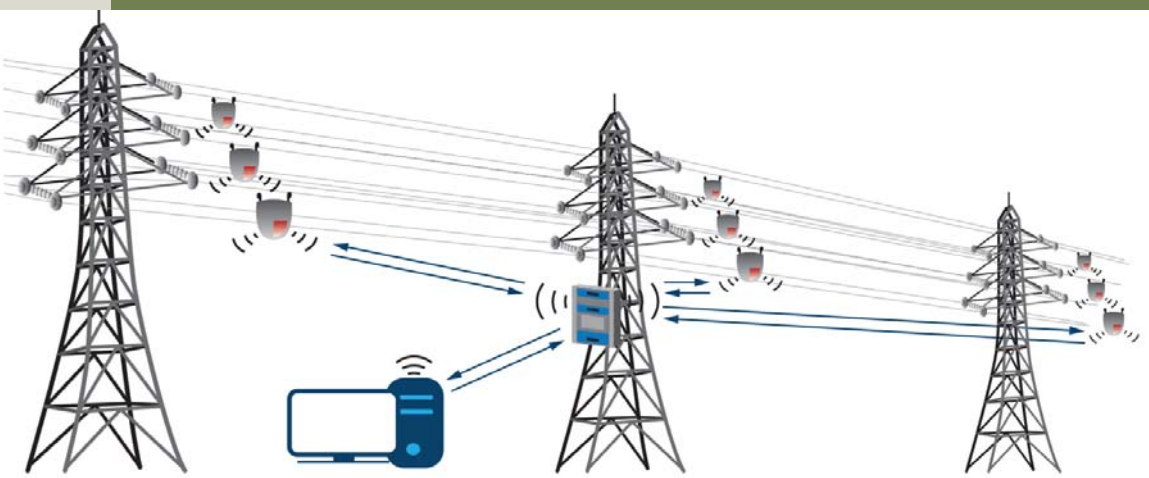
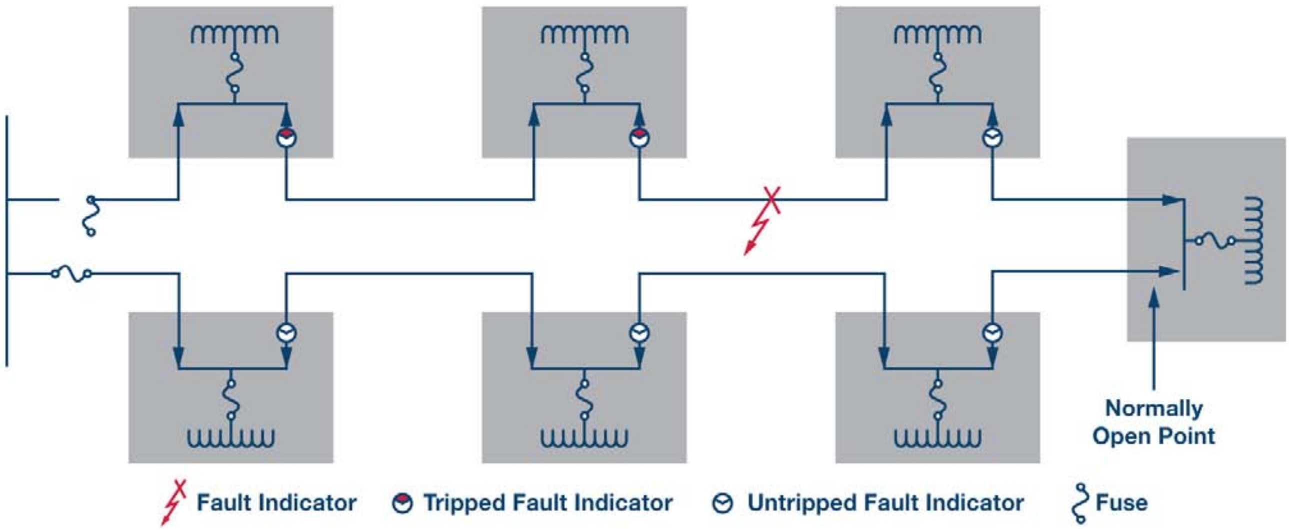


Figure 2



problem's source was difficult. How then do utilities improve the distribution network architecture to achieve better outage response? The answer lies in taking advantage of better line sensor technology that lowers system cost and allows more nodes to be deployed within the power infrastructure. This technology features more integration, helps achieve better measurement accuracy, consumes less power and requires less maintenance.

One of the most common use-cases for new line sensors is a node monitoring system known as a fault indicator. It detects and sends an alert when problems occur so that line crews can service faulted equipment with minimal delay. Figure 1 shows fault indicators in use on power distribution lines. Many names are used across different geographies and different suppliers to describe this same system, including line monitor, fault monitor and fault circuit indicator. Throughout this article, the general term fault indicator describes the system, line sensors and underlying technology that is used to detect the physical state of power lines.

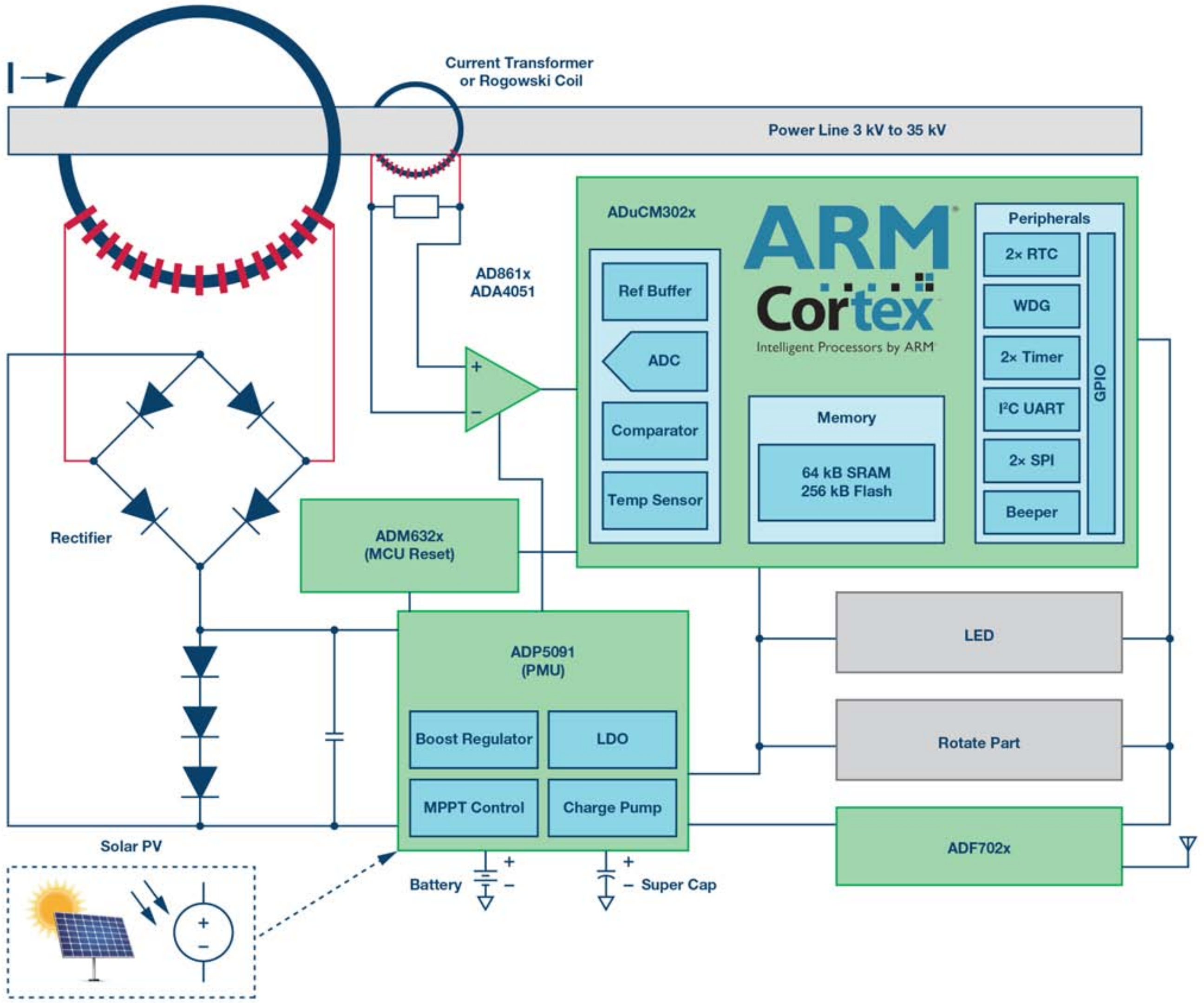
In underground applications, as shown in Figure 2, a fault indicator is placed at cable terminations along each primary cable. The indicators upstream of the fault will trip, and the indicators downstream of the fault will remain in the non-tripped position. As a result, the service team can easily identify the faulted section of cable or equipment without going through a time-consuming isolation process. Underground applications can include transformers, switchgear, cabinets, junction boxes and splices.

In overhead applications, the easy-to-spot displays on fault indicators lead the line crew to the line's problem section. Overhead applications can include unfused taps, long feeders with midline reclosers, sectioning switchgear, transitions and feeders.

By employing better power management, fault indicators will need less maintenance because line crews can replace batteries less often and they can perform fewer system checks.

Two of the biggest challenges associated with existing fault indicators are No. 1: they can be expensive to purchase in volume and No. 2: they require recurring maintenance to continue to function properly. Cumulative purchase cost and recurring maintenance are two primary reasons why utilities with limited budgets and resources cannot deploy more fault indicators within their vast power infrastructure.

Figure 3



Improving Fault Indicators Through More Advanced Power Management

To address these challenges, a new line of sensor architecture for fault indicators that harvests power at high efficiency and requires less maintenance is available. (see Figure 3).

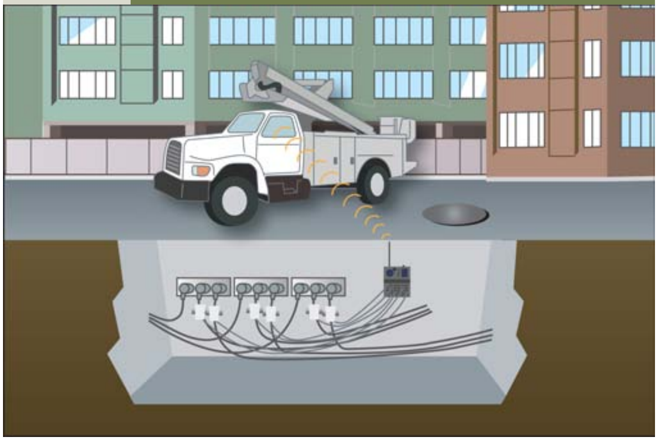
While basic functions might seem simple, a power-harvested fault indicator design is complex. It starts with power supply architecture. Three independent power sources—the power line sensor, a rechargeable battery and a super capacitor—are necessary, in addition to a control algorithm that knows how to balance changing supply conditions with changing load conditions—all while guaranteeing always-on operation. The key innovation is a new multiple power path design technique that enables faster start-ups, lower power consumption and smoother operation for the system. By employing better power management, fault indicator maintenance is reduced because line crews don't need to replace batteries as often nor do they need to perform as many system checks.

New fault indicator designs can also leverage more sophisticated data collection and more robust wireless communications to boost performance. They can capture more granular data by using high speed precision converters to collect power line information at data rates that are much higher than electrical power frequencies. The reach of these devices also is improved through integrated wireless communications such as short wave radio and GSM protocols (see Figure 4). Fault indicators can transmit data and communicate their status so that line crews spend less time searching for faults and more time troubleshooting them.

Big Data Analytics Drives Better Energy Intelligence

Fault indicators that take advantage of advanced line sensor technology present opportunities for utilities to transform the

Figure 4



way they operate. By collecting more granular data at the node, being better connected and implementing equipment that is less expensive to maintain, utilities can identify and respond to outages faster and with higher confidence. There are other possibilities to consider, however. For example, an entire population of fault indicators can provide historical data and alerts so that utilities can apply machine learning algorithms and analytics to drive more efficient line crew activity, lower operating expenses and achieve better business outcomes.

Summary

Utility customers often experience prolonged power outages because problems are difficult to locate. One way utilities can remedy this scenario is through broader adoption of fault indicators. New line sensor technology for fault indicators that harvests power at higher efficiency and reduces maintenance requirements is now available. This new technology allows utilities to take advantage of next-generation fault indicators and benefit from shorter outages, lower operating expenses and more satisfied customers.

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