system. Since 2014, several DNP3-capable commercial packages have been released, and Belden was preparing a DNP3-capable Tofino firewall as Spectrum went to press in April.

Visualization tools designed to highlight anomalies in SCADA traffic patterns are another recent innovation. These include systems developed by Lee's firm, Dragos Security, and NexDefense, an Atlanta-based spin-off of Idaho National Laboratory, in Idaho Falls. Lee says that monitoring and visualization tools are not panaceas guaranteeing security but rather a "starting point" for identifying and countering intrusions.

To date, uptake by utilities is slow. Sistrunk says he knows of only four or five leading utilities that widely deploy SCADA monitoring and intrusion detection. Only one has presented research on its use of SCADA monitoring, and that utility requested that Spectrum withhold its name, arguing that such publication would "paint a target" on its networks.

The latest updates to NERC-CIP should accelerate deployment. They add, for the first time, mandates for continuous network monitoring and deployment of network defenses to detect or block malware and malicious communications. The broader standard will help, says Sistrunk, if utilities do more than the bare minimum required to check off a box on a compliance list. As he puts it, "Monitoring will increase. However, monitoring for compliance and monitoring for security aren't exactly the same thing."

Doug Wylie, a NexDefense vice president, expressed similar concerns in March after utility trade groups successfully petitioned to delay the new mandates' start date from April to July. The delay, wrote Wylie on NexDefense's blog, "underscores the need for the energy industry to create a security culture that prioritizes the mitigation of dangerous and frequent cyber threats."
—PETER FAIRLEY

WHEN WILL GOOGLE'S SELF-DRIVING CAR *REALLY* BE READY?

It depends on where you live and what you mean by "ready"

> **If you're one of the mil-**lions of people pining to own a Google self-driving car, you'd better make yourself comfortable, because you may be in for a much longer wait than you ever expected. Not only that: There's a distinct chance that once you get behind the wheel of the first commercial version of the Google car, it may not be able to take you where you need to go.

In 2011, soon after Google first told the world about the robocars it had secretly been

SOON FOR SOME: Google's vision of a car that can take you anywhere might take longer to achieve, depending on where your "anywhere" is.

developing, it promised that the vehicles would be able to "drive anywhere a car can legally drive." The company's time frame for delivering the technology was generally understood to be in the neighborhood of five years. For example, in a 2014 *Wall Street Journal* article, project director Chris Urmson was quoted as saying he was hoping "to field a fully autonomous car" by the end of the decade.

But in a speech he gave in March at South by Southwest, in Austin, Texas, Urmson for the first time told a different story about both the delivery date and capabilities of Google's first self-driving cars.

Not only might they take much longer to arrive than the company has ever indicated—as long as 30 years, said Urmson—but the early commercial versions might well be limited to certain geographies and weather conditions. Self-driving cars are much easier to engineer for sunny weather and wide-open roads, and Urmson suggested the cars might be sold in those markets first.

Urmson put it this way in his speech: "How quickly can we get this into people's hands? If you read the papers, you see maybe it's three years, maybe it's 30 years. And I am here to tell you that honestly, it's a bit of both."

He went on to say, "This technology is almost certainly going to come out incrementally. We imagine we are going to find places where the weather is good, where the roads are easy to drive—the technology might come there first. And then once we have confidence with that, we will move to more challenging locations."

In an interview, a Google spokesman agreed that Urmson was describing some aspects of the project differently than the com-

pany had in the past. But he took exception to the notion that Google was announcing any sort of delay, instead describing Urmson's potentially decades-long delivery window as an "expansion" of what he has said in the past. The spokesman also denied that Urmson's description of an incremental commercial rollout represented any sort of strategic change.

In a later written statement, the spokesman said the company's basic goals for the program were unaltered: "We want to make fully self-driving vehicles available soon to as many people as possible given the potential benefits for road safety and for those whose mobility is limited by their inability to drive a car, but we'll do it in a safe and thoughtful manner."

Others interpreted Urmson's speech differently. "This is the most conservative road map they have ever talked about publicly," says Edwin Olson, who researches self-driving cars at the University of Michigan, in Ann Arbor.

Ian Grossman, a vice president of the American Association of Motor Vehicle Administrators, which works with state agencies that regulate such vehicles, says Urmson's speech was the first time he'd heard that Google might commercialize its cars in stages, rather than introduce the model the company initially described: a car that, like today's automobiles, could go essentially anywhere.

Any shift by Google in its self-driving car plans would be significant, because while there have been skeptics, much of the world has taken it for granted that the major technology challenges of fully computer-controlled vehicles have been worked out, and that Google was on track to deliver them in the near future. The expectations are so high that lawmakers are now being urged to scrap support for mass transit programs, which, some argue, won't be needed in an era of ubiquitous self-driving cars.

Much of that optimism about self-driving cars is the result of press coverage of the Google project. But the University of Michigan's Olson says those stories haven't always conveyed the extent of the remaining challenges with the technology, which he describes as considerable, especially considering Google's clearly stated ambition to develop a fully computerized car without either a steering wheel or brake pedal.

Google has, Olson says, "a superabundance of optimism and enthusiasm for their vision. But the consequence is that they've projected the idea that this problem is going to be solved very soon." —LEE GOMES

> "This is the most conservative road map they have ever talked about publicly" —Edwin Olson, University of Michigan

THREE SUPER-COOL TECHNOLOGIES

A robotic AC, an office chair on ice, and cool insoles

Like most U.S. government depart-ments, the Advanced Research Projects Agency-Energy tends to bury its programs in strained, dull-sounding acronyms like DELTA, which stands for Delivering Efficient Local Thermal Amenities. But the DELTA project is, fortunately, much cooler than it sounds: It's about finding ways to move climate control from the building level to the personal level.

Air-conditioning is more of a pressing problem than you might think. A growing global middle class means more demand for air-conditioning, especially in places that really need it, such as India and Indonesia. When they accounted for climate change and increasing incomes, researchers at the Haas School of Business, at the University of California, Berkeley, found that the fraction of homes worldwide with air-conditioning will rise from 13 percent to more than 70 percent by the end of the century. And all those ACs will need a lot of electricity.

The problem that ARPA-E wants to solve with DELTA is the ridiculous amount of energy that we waste heating and cooling buildings that are, strictly speaking, almost entirely unoccupied. When you turn on the heat or the AC, you're dumping energy into changing the temperature of an entire structure, when all you really care about is the microclimate surrounding you. And if some people like it warmer and some people like it colder, one of those two groups is doomed to misery.

A much better approach is to develop technologies for highly localized and customizable temperature control. Why bother heating or cooling an entire building when all the people inside it can instead customize their own little climate bubbles to their ideal temperature? Here's a look at three different technologies from ARPA-E's annual Energy Innovation Summit that are in the process of moving from prototype to commercial reality within the next two years. —EVAN ACKERMAN