MATT ALDERTON JANUARY 6, 2016 5:10

"Array" of Possibilities: Chicago's New Wireless Sensor Networks to Create an Urban Internet of Things

If it hasn't already, your daily routine will soon undergo a massive makeover.

For starters, when your alarm clock goes off, it will tell your coffeemaker to start brewing your morning joe. Then, when you're on the way to work, your car will detect heavy traffic and send a text message to your boss, letting her know you'll be late. When you arrive, you'll print out the agenda for today's staff meeting, at which point your printer will check how much ink it has left and automatically order its own replacement cartridges.

At lunch, you'll think about dinner and use your smartphone to start the roast that's waiting in your slow cooker at home. And when you come home a few hours later, your house will know you're near, automatically turning on the lights, the heat, and the TV—channel changed to the evening news—prior to your arrival. It will be marvelous, and you'll owe it all to the Internet of Things (IoT).

The IoT won't just make your life easier; when it's embedded in cities the same way it's embedded in homes, cars, and offices, it also has the potential to make your life better.

Artist rendering of Array of Things nodes mounted on city streetlight poles. The AoT is an urban-sensing instrument, measuring data on cities' environment, infrastructure, and activity in order to scientifically investigate solutions to urban challenges ranging from air quality to urban flooding. Courtesy Douglas Pancoast and Satya Mark Basu, School of the Art Institute of Chicago/AoT.

That's the hypothesis in Chicago, where a project is underway to establish wireless sensor networks capable of measuring a city's vitals in the same way a fitness tracker measures an athlete's.

"This is a Fitbit for the city that will allow us to collect a really wide array of environmental data . . . which will help us make better decisions about what types of infrastructure to invest in," City of Chicago Chief Information Officer Brenna Berman told local business publication *Crain's Chicago Business*.

Called the "Array of Things" (AoT), the project is a collaboration of the University of Chicago and Argonne National Laboratory—which have formed a joint venture known as the Computation Institute—along with the School of the Art Institute of Chicago, Northern Illinois University, and the University of Illinois at Urbana-Champaign. All of these institutions have contributed to a multidisciplinary team of designers, engineers, and scientists who are pioneering the concept of distributed sensor networks in cities, starting with the Windy City.

Funded by a $3.1 million National Science Foundation grant, their work initially will comprise 500 modular sensor boxes, called "nodes," installed across Chicago by the end of 2017. Inside each one, a bundle of sensors will collect a litany of urban intelligence, including 24-7 data on traffic, air quality, weather, and noise.

"There are a range of scientific and policy questions that our partners in universities and the City of Chicago would like to pursue, but we don't have data with adequate resolution in space or time to really answer those questions," explains Charlie Catlett, AoT's principal investigator and director of the Computation Institute's Urban Center for Computation and Data. "With the Array of Things, we set out to put in place a network of sensors that will allow us to measure the city in greater resolution."

AoT node prototype. Courtesy University of Chicago and Argonne National Laboratory.

Measuring cities will help scientists and policymakers improve them by making it possible to prioritize urban projects based on which ones will have the greatest impact. Just as important, facilities like AoT will help cities measure the outcome of major investments in areas such as air quality, urban heat island effect, and walkability.

"In the U.S., we have districts that are trying to improve walkability, energy efficiency, or just general quality of life," Catlett says. "Unfortunately, many investments are made without rigorous and quantitative capabilities to measure whether they have the intended impact."

AoT changes that with data streams from three different families of sensors: environmental sensors, which will measure temperature, humidity, barometric pressure, light, noise, and vibration; air-quality sensors, which will measure the presence and concentration of up to eight different gases, including pollutants like ozone, carbon monoxide, and nitrogen dioxide; and activity sensors, which will monitor for standing water and urban flooding while counting pedestrians, bicycles, cars, trucks, and buses.

"Roughly every minute, we'll send all the data we collect to a centralized database at Argonne National Laboratory, and from there, we'll publish it for the scientific community and the general public," Catlett says, adding that the data will be published in a variety of ways to make it accessible to nonscientists. "Our aspirations are that these devices are considered by people who live in the community to be *their* devices measuring the city, not the *city's* devices measuring them. We want this to be a public-private partnership not only between the city and universities but also with communities."

Rendering of the AoT in Chicago. Courtesy Douglas Pancoast and Satya Mark Basu, School of the Art Institute of Chicago/AoT.

AoT's community partnerships represent a sort of covenant with citizens, whose privacy concerns are an issue that the project takes very seriously.

"Our privacy policy starts with these devices publishing all their data openly and freely," says Catlett, who points out that data is processed at street level by individual nodes. "No personal information will be collected by these boxes, stored in them, or transmitted elsewhere to be saved. In terms of the cameras we use, images are taken, processed, and then discarded."

The nodes' design is as notable as the policies that govern them. "We sat down with collaborators at the School of the Art Institute of Chicago's Department of Architecture, Interior Architecture, and Designed Objects and conceived an asset that's on a pole in a neighborhood where people can actually interact with it," explains Catlett, who envisions nodes that eventually will be integrated in cities' LED streetlights. "One goal was that it needed to protect the electronics inside while still allowing sensors to sample the environment outside. A second goal was that it needed to be conspicuous and inviting—to encourage people to ask what it does. Finally, an individual needed to be able to interact with it either directly or mediated through a mobile device."

Installation of AoT node prototype. Courtesy University of Chicago and Argonne National Laboratory.

Although nodes' design and placement is still being finalized, positive impact on Chicagoans' daily routine is palpably near. By the end of the first quarter of 2016, 50 nodes will be installed across the city. By the end of the second quarter, 150 more will be measuring Chicago neighborhoods. And by the end of summer 2017, an additional 300 nodes will grace city streets.

Once enough data is aggregated, the city will be able to leverage it to improve city services and infrastructure while citizens will be able to leverage the data to avoid asthma triggers on their way to work, receive "block-by-block" weather forecasts, and determine safe and efficient routes for walking late at night. "If you're somebody who's into the quantified self and the Internet of Things, you're going to be excited by the notion that you'll be able to look at the end of the month not only at the number of steps that you took but also at your exposure to carbon monoxide and excessive noise," Catlett says.

The AoT already has partners in 15 other cities—including Seattle, Portland, and Mexico City, just to name a few—that want to install nodes in their communities. "And even if you're not enamored with technology, you should be excited about the fact that your city will be in a position to take scientifically based actions to improve life for citizens," Catlett says. "Because if you can design an intervention based on data instead of best guesses, chances are, you're going to see better results from your investment."

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