REALIZING THE INTERNET OF THINGS

text by Wanda Lau
illustrations by David Preiss

Lightfair's first-ever IoT & Smart Lighting Forum showcased the enthusiasm of established lighting companies and tech startups to make luminaires invaluable to an information-driven future.

The Internet of Things (IoT), in which everyday objects are made intelligent through sensors, microprocessors, and machine-to-machine communication, ascends into the Industrial Internet of Things when IoT objects are networked together to control large-scale systems, such as the lighting infrastructure of an entire city. But Joe Costello, CEO of tech startup Enlighted, in Sunnyvale, Calif., offered his own take on the phenomenon during his opening keynote at Lightfair's inaugural IoT & Smart Lighting Forum this year: He called it IQoT, after the intelligence quotient test. The networking of objects together should not only enable remote user control, he said, but also collect, process, and analyze data in an intelligent way. "That's when it's interesting," he concluded.
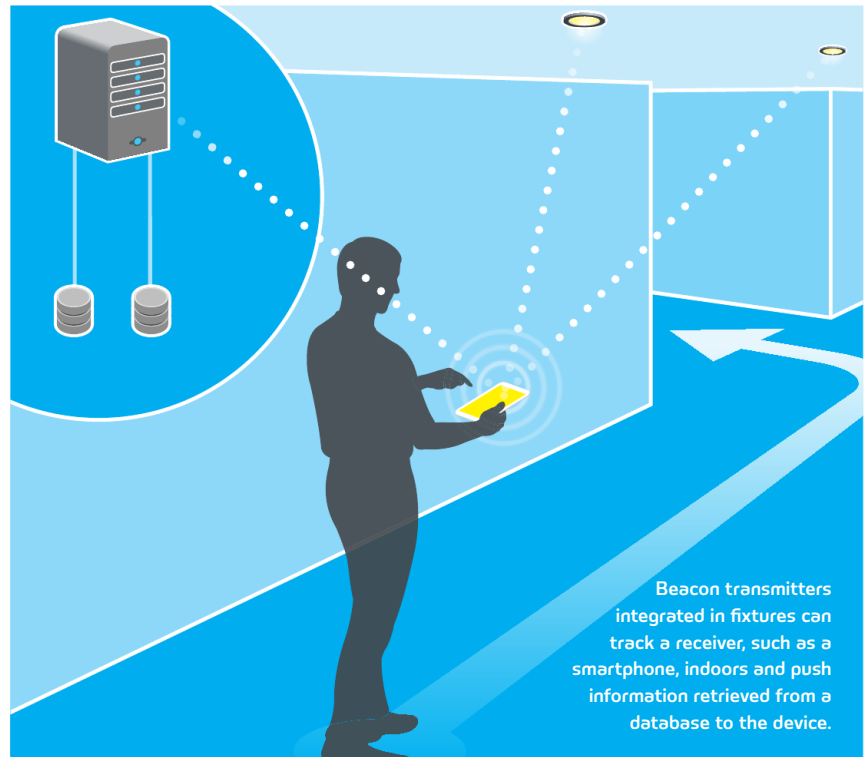
Enlighted was one of several companies at Lightfair exhibiting IoT technology that integrates into interior and exterior light fixtures, which in return provide IoT sensors power and an unparalleled position, literally, to see the environment around them. IoT does offer ample opportunities in lighting control, but more importantly, it offers the ability to track nonlighting metrics, such as building performance, human activity, and physical assets. For example, Costello noted, in a North American hospital, the average nurse spends an hour of each workday looking for equipment, which translates into wasted time and money, and even to unnecessary overnight stays for patients, who can only be discharged in wheelchairs, which frequently go missing.

Major lighting companies, including Current by GE, Philips, and Acuity, are now developing IoT platforms in partnership with technology companies such as Enlighted, Sensity Systems, and Daintree Networks (which is now a part of Current by GE), as well as companies with a major foothold in cloud computing such as Cisco, Oracle, and Microsoft. But the relatively nascent IoT space has room for plenty of players, including the companies featured in this article that presented at the Lightfair forum about the areas of expertise they are tackling to take IoT from what may sound like a far-fetched future to a ubiquitous service that is being deployed today.

INDOOR POSITIONING POSSIBILITIES

Many presenters at Lightfair's IoT forum highlighted smart lighting's ability to continue where GPS tracking leaves off: at the building entrance. GPS, which relies on satellite information to triangulate a signal's location within 1 to 5 meters (3 to 16 feet), loses its accuracy once an individual—or more accurately, a GPS-enabled device, such as a smartphone—steps indoors. Because all smartphones operating on the Android or iOS
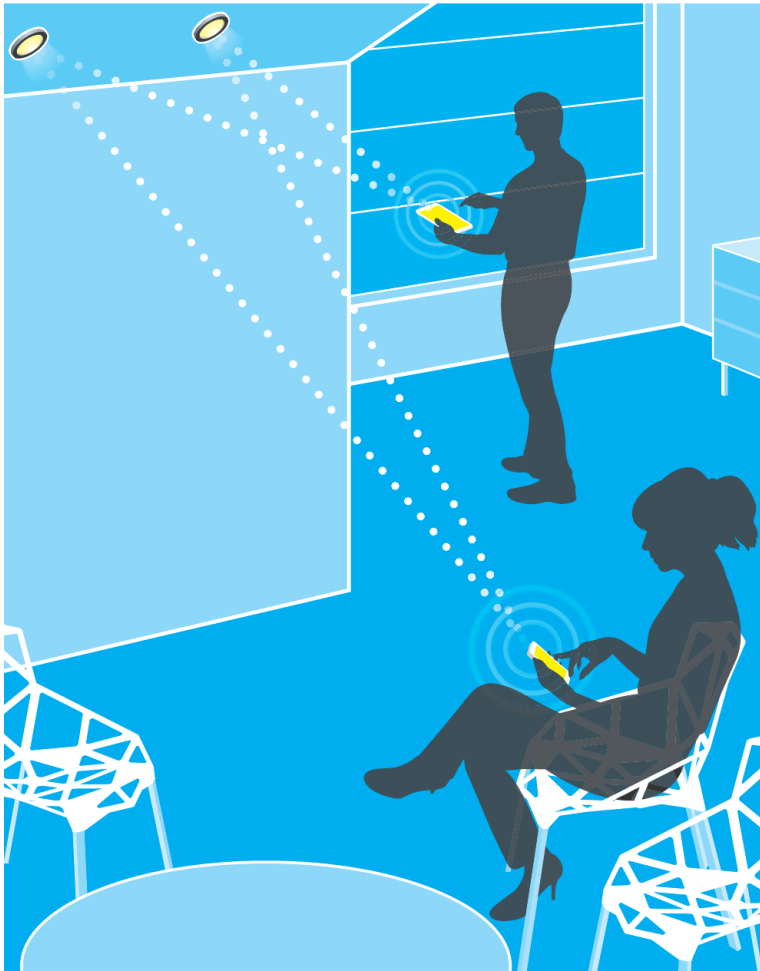
platforms are Bluetooth and Wi-Fi enabled, a sensored lighting network would be able to continue to track the device within a couple of meters, opening the door to a whole new class of location-based apps—including the tracking of assets, such as those mysteriously misplaced hospital wheelchairs. (Visible light communication [VLC] offers accuracy to within a few centimeters, but it does require the receiving device to have a photodetector facing the signals.)

Belleds, a Cambridge, Mass.–based designer of smart-lighting products, offers a Bluetooth chip and module for LED fixtures that both enable wireless lighting control and broadcast the location of the fixture (this is also known as a beacon). As a smartphone detects the beacons in the luminaires, the device's location can be tracked to within the nearest meter or two, depending on the density of beacons in that area.

If a client wants only to use an LED fixture as a physical platform to install beacon technology without gaining addition lighting control, Belleds co-founder Alan Zhou says that integrating the chip simply requires tapping into the DC power supply for the LEDs. "Today, most of the

Beacon transmitters integrated in fixtures can track a receiver, such as a smartphone, indoors and push information retrieved from a database to the device.

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Bluetooth Low Energy chips only consume a couple microamps during standby mode; and a couple milliamps during transmission, or active mode," Zhou says, citing the lower-power and app-friendly version of the Bluetooth communication protocol.

If a client also wants wireless control of the lights, in addition to using them as beacons, Belleds offers a patented module—which installs between the LED driver and the diodes—that delivers both positioning information and lighting control, using pulse-width modulation, of an LED source's four color channels (red, green, blue, and white) to produce any color from the luminaire, as well as on/off control.

Belleds also found a way to overwrite the control protocol that generally limits Bluetooth devices from pairing with more than one device, allowing multiple parties to access a building's lighting system. "You can have the controls as well as the positioning all in one," Zhou says.

POWER OVER ETHERNET POE-TENTIAL

Power over Ethernet (PoE) is becoming a more viable option to create smart lighting. The low-voltage distribution system delivers a connection to the Internet and power to the luminaires—as well as other integrated sensors and control devices—over the global Ethernet standard. "If you plug something into a PoE switch, the power you're going to get is universal," says Lisa Isaacson, co-founder and chief business development officer of NuLEDs, in Carlsbad, Calif.

PoE-plus cables (CAT-5e or CAT-6) can deliver 30W, while Cisco's Universal PoE (UPoE) cables can deliver 60W over the four pairs of twisted conductors within an Ethernet cord. "That's a sweet spot for being able to [power] a wide assortment of LED fixtures [including] 2×2 troffers, 2×4 troffers, canlights, covelights, and sconces," Isaacson says.

The essential components of PoE system are: an uninterruptible power supply; a UPoE network switch, which detects whether to send power to the devices connected into its ports; and a PoE module, such as NuLEDs' proprietary SpiceBox. The NuLEDs SpiceBox converts the incoming AC power to DC power for the LEDs and sensors plugged into it. It also assigns a unique IP address to each device, giving each of them the ability to broadcast its location and to receive network information and control commands.

An advantage of PoE as an IoT technology is the safety it offers in electrical wiring; each light plugs into a low-voltage Ethernet port. "Instead of stepping down the power level at each and every fixture, you're doing [the conversion] on one robust power supply," Isaacson says. This also means that LED luminaires designed for PoE (NuLEDs currently has partnerships with Deco, US LED, and Fluxwerx Illumination) no longer need a discrete driver.

PoE also increases design flexibility because anyone can relocate a light fixture without the need to call an electrician. This also leads to one logistical challenge: Who is in charge of servicing the fixtures? Instead of calling the facilities department, building occupants would need to contact their IT department, who can then ping—or check the network connectivity of—a luminaire but may not be trained to troubleshoot the fixture itself.

ACHIEVING IOT'S PROMISE

Despite the promising technologies presented at Lightfair's IoT Forum, the groundwork is still being laid for taking smart lighting from
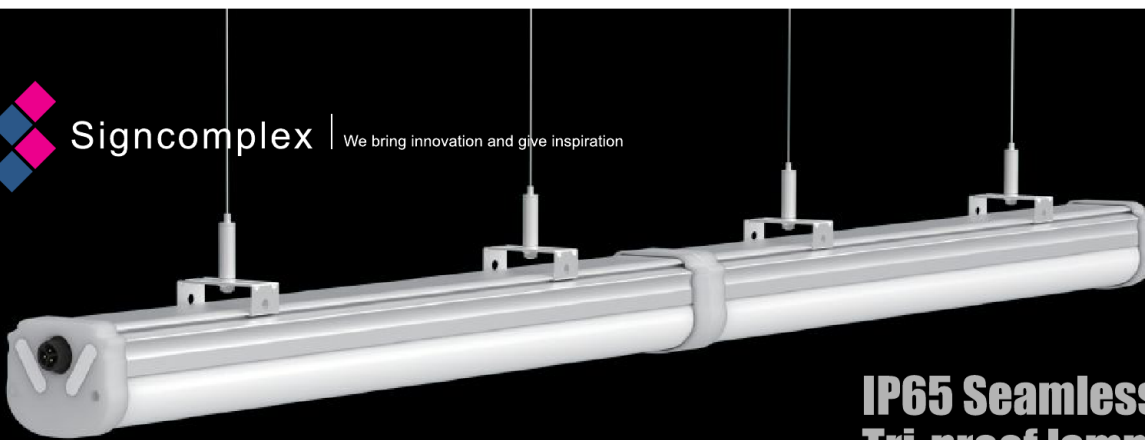
proof-of-concept to mainstream use. Many players in the field are now seeking to reach critical mass—deploying IoT devices on a large enough scale in order to gather the volume of data needed to entice app developers, and to test the reliability and security of the data. "The data streams and the apps that depend on them are where the value is," says Enlighted founder and chief technology officer Tanuj Mohan. "The promise is huge, but you have to step in a little to understand the information and how accurate it is."

During his Lightfair presentation, Brandon Davito, a vice president at San Francisco–based Silver Spring Networks, noted how Metcalfe's Law also applies to IoT: the value of a network is equivalent to the square of the number of devices deployed.

Lighting designers working with clients interested in installing a smart-lighting network on their projects should ask them: first, what information do you want to know; and, second, why do you want to know it? For example, do you want to know how many people are in a conference room, or do you want to know who is in a conference room?
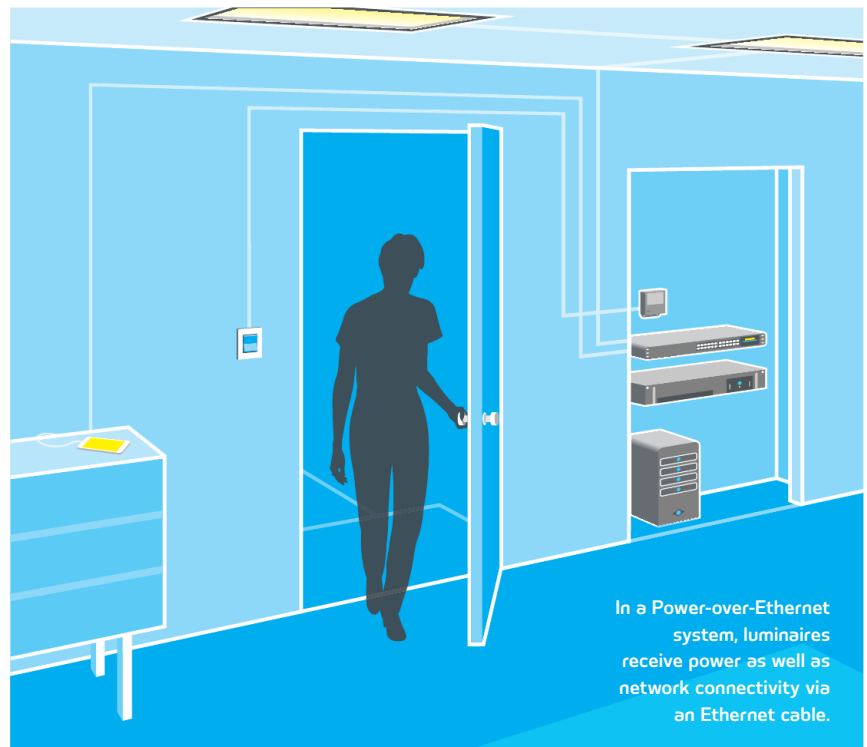
In a Power-over-Ethernet system, luminaires receive power as well as network connectivity via an Ethernet cable.

The Vode DoubleBox™ suspended LED provides both direct and indirect light for open office, conference room and classroom applications. It's 1,900 lm/ft at its most efficient. **What's not to love?**

Cost will no doubt play a role in which type of sensors are deployed and how quickly they are deployed. One way to save on expense is to install fewer sensors, Mohan says, which would give you coverage in specific zones instead of full coverage. Another way is to strategically choose what type of sensor to use. For example, you don't need a high-resolution imaging sensor for each IoT node if the only information you need is indoor-positioning data.

Mohan does recommend picking a system that is future-proof, to the extent possible. A sensor that "is built like a computer" and has "a processing unit with software that can be continuously upgraded" remotely, he says, will minimize the time and expense of going back up into a fixture.

Not surprisingly, all presenters at the Forum said that smart lighting represents a good investment. Because IoT-enabled fixtures can self-

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>
> **—Tanuj Mohan, chief technology officer, Enlighted**

commission, Kishore Manghnani, co-founder and CEO of Orama, in San Mateo, Calif., said teams can save as much as 60 percent in project costs immediately. Davito noted than an additional 10 to 20 percent in savings can be gained because of improved lighting controls, and then another 15 to 25 percent in reduced operation and maintenance expenses. This does not account for the improved energy efficiency of LEDs over conventional sources, nor for the more abstract savings reaped in benefits such as improved safety and space management. All in all, the return of investment (ROI) of upgrading the lighting infrastructure could be as quick as a couple years.

Mohan does caution decision makers and facility managers from prioritizing ROI in their selection of an IoT platform and system. He recommends that they ask this question: "Is my responsibility to the building or the humans in the building?" If the IoT system installed is optimized for the structure, but its occupants experience minimal improvements in productivity, happiness, or safety, he says, then the decision was likely made with the wrong metric in mind. •