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BUILDING A SMART CITY

Cities must master the flow of information to create a digital infrastructure that makes life better.

By John Kosowatz

It was going to be a gleaming ghost town, shimmering amid an arid expanse of southeastern New Mexico. Energy and infrastructure consultant Marble Arch Partners proposed building The Center for Innovation, Testing and Evaluation to do full-scale testing of the smart cities systems and technologies that will define the future of urban development.

The ambitious plan called for spending $1 billion to build an uninhabited city large enough for 35,000 people, fitted with intelligent building, transportation, and energy systems. Without human drivers on the road or children playing in the streets, engineers could test new systems without worrying about disrupting everyday life. Drones could hover over autonomously operated vehicles while streetlights watched buses to see if they were running on time.

Five years after the announcement, ground still has not been broken and the window may be closing. Instead of running tests in the middle of nowhere, cities are installing smart systems at an increasing pace, beginning with pilot projects and expanding them as the results prove out. Using their own infrastructure as a test bed, their results promise to change how cities manage utilities and services while providing citizens with tools to exploit the information they generate.

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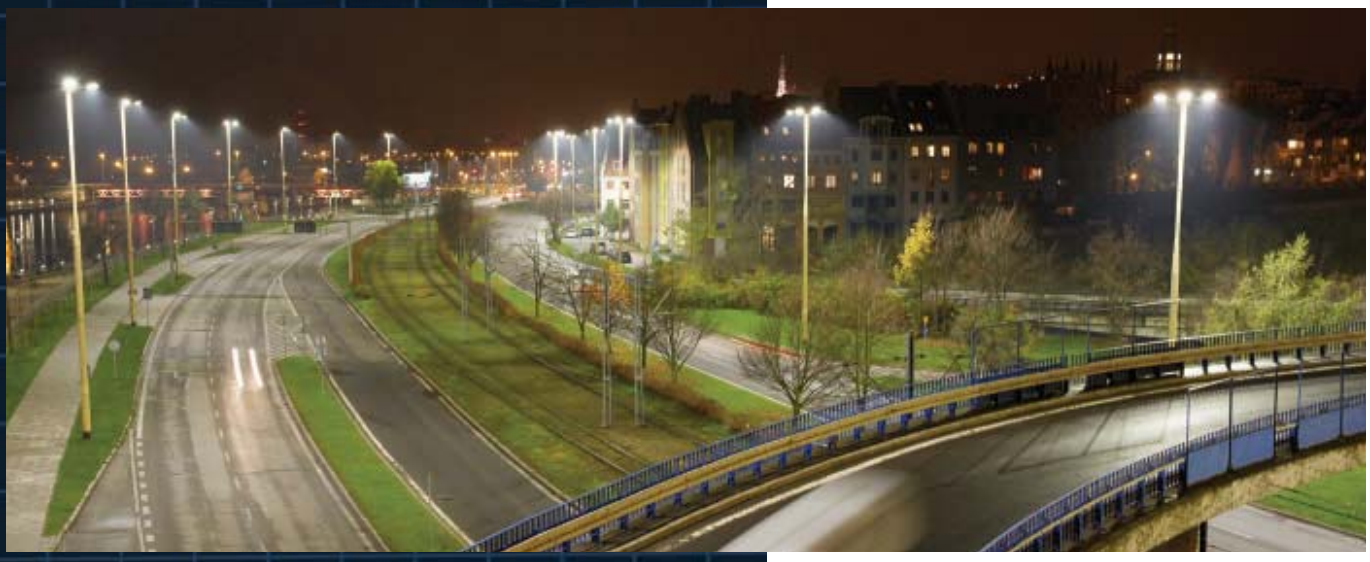
—RYAN CITRON
NAVIGANT ANALYST

According to a report by Navigant Research, smart cities are a global phenomenon. There are 250 projects underway in 178 cities worldwide, with Europe leading the way because of its aggressive climate change policies. The research firm estimates the global market for smart city technologies and services to be worth $40.1 billion in 2017, with growth expected to reach a whopping $97.9 billion by 2026. Barriers to entry are falling as sensors improve and smart technologies grow more efficient, more capable, more interoperable, and less expensive.

In a smart city, wireless motion and flow sensors, low-cost video cameras, temperature and noise monitors, and air quality devices feed data continuously into systems, which use them to control traffic lights, streetlights, pedestrian displays, power distribution and more. Cities use them to monitor traffic, mass transit, pedestrian flows, and crime. All these devices link with rugged wide area networks that send data to the cloud, where powerful analytic engines the data to make cities efficient and safer.

"There are so many different technologies, but lighting is one of the big growth areas," said Ryan Citron, a Navigant analyst who co-authored the report. "LED lighting is becoming the go-to replacement technology."

There are two key reasons why LEDs have become the foundational technology of smart city networks, Citron said. First, they offer energy savings of up to 80 percent and a fast payback period. Second, each light carries a microprocessor, making it a potential node in a system that is ideal for setting up a wireless wide area network.



These networks create a scaffold that supports the buildout of future smart system capabilities.

LEVERAGING DATA

San Diego officials are spending $30 million to make their city smarter. The effort, the most ambitious in the world, involves replacing 14,000 streetlights with LED lights and 3,200 sensors. Those sensors will gather information on everything from vehicular traffic and pedestrian movement to changes in air quality. The data will enable the city to reroute emergency vehicles around congestion, smooth the flow of the daily commute, and point drivers to vacant parking spaces as they come available.

Just as important, San Diego's emerging open-source platform will put raw, anonymous data in the hands of entrepreneurs searching for new opportunities and citizens looking for ways to make city life better, said David Graham, the city's deputy chief operating officer.

San Diego has both an educated population and a strong tech startup community, and Graham is actively courting two-way interaction with them by sponsoring hackathons using city data. A favorite that has emerged from those sessions will tell food trucks where people are congregating and where they can park.

Entrepreneurs could also use the data for more traditional market research, analyzing pedestrian traffic to decide where to locate a new retail store or how much rent to charge for commercial property. The system was developed by GE, which now is deploying it through a spin-off, Current. It retrofits existing lighting infrastructure by installing energy-efficient LED lights that are fitted with sensors, controls, wireless transmitters, and microprocessors.

"By repurposing light poles, you can transform to a digital infrastructure," said Austin Ashe, general manager of Current's intelligent cities program. "This becomes a digital engine that extracts metadata from the environment."

Of course, smart hardware needs equally smart software. GE believes that it has a proven system in its Predix software platform, which is already used by industry to generate operating data from factory machines and devices.

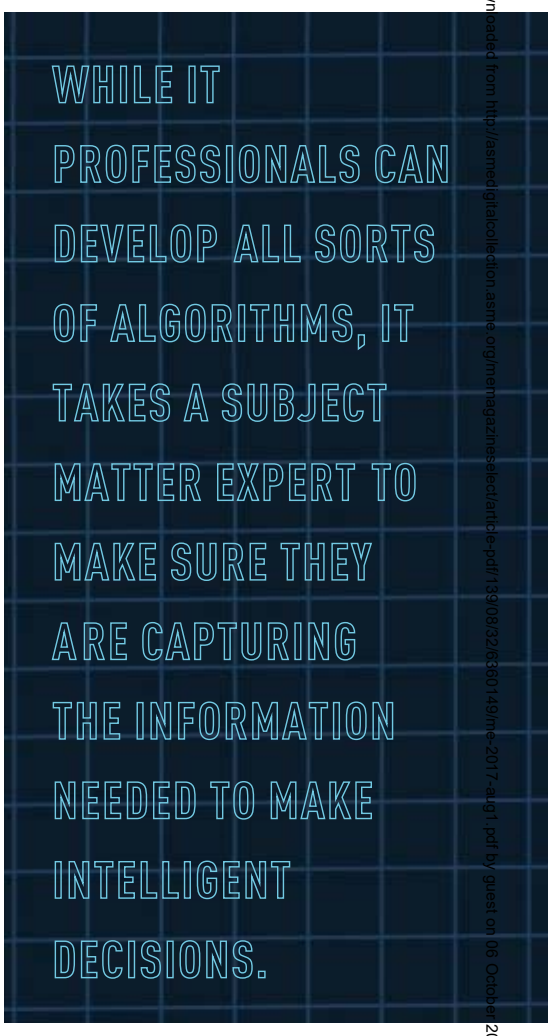
In cities, the networked system extracts "very granular" data in real time, and retains historical data it can use to predict trends in the movement of people, traffic, or whatever topic city officials identify.

"It also creates an opportunity to leverage the data with the broader software development community," Ashe said. "It allows the broader community to take the data and transform it into an appropriate application."

In fact, smart city applications generate more data than most cities can use. The volume of data is intimidating, said Ken Thompson, global technology leader for smart cities and sensors for engineering giant CH2M. "It scares a lot of people to death about how to process all of that data," Thompson said.

As a result, many industries and cities today use only a small fraction of the data available to them, he said. In one internal survey, Thompson found that water clients process only about 10 percent of their data. That is not efficient, though it is driving the development of faster analytics engines that can process large volumes of data more quickly.

"That data crunching ability is important," Thompson said, "but when you're developing the technology, you must have a subject matter expert involved." While IT professionals can develop all sorts of algorithms, it takes a subject matter expert—someone who understands city traffic or water distribution—to make sure they are capturing the information needed to make intelligent decisions.



DATA-DRIVEN DECISIONS

GE first approached San Diego when city officials were dealing with the result of years of underinvestment in infrastructure.

"Looking forward, rather than replace what we had with something that was just a little better, it became a conversation about building an intelligent platform," Graham said. The two parties

decided to build a pilot network using 40 streetlights in San Diego's East Village neighborhood.

"After putting the sensors in the lights, we developed enough information for a parking application," Graham said. The city found there was a value proposition with parking, and that it could use sensors to identify abandoned vehicles and other roadway threats.

Just by themselves, the upgrade to LED lights made a lot of sense, Graham said. "With 2,000 lights, we found we could save a quarter-million dollars and cut energy use up to 60 percent."

Overall, the city expects a 13-year payback period for the entire project.

Yet the networked smart lights gave San Diego a new way to provide better and more site-specific neighborhoods services. For example, it could dim lighting around the nearby Palomar Observatory and in areas where people need "dark sky," Graham said. At the same time, the city could intensify the lighting elsewhere, depending on pedestrian and vehicular traffic data provided by their sensor.

Like GE, Mumbai-based Tata Consultancy Services provides real-time data and predictive models. It claims that its Intelligent Urban Exchange platform's machine learning technology cuts the payback period for LED lighting almost in half. It uses machine learning to build models that customize the operation of individual streetlights based on such historic data as crime patterns and pedestrian and vehicular traffic. The platform will suggest optimal streetlight brightness and the most cost-effective schedule to save energy.

Tata is using the same platform to optimize public transportation in Belfort, a city of 50,000 in eastern France. Belfort operates 100 buses along five bus routes. Tata's system gathers data such as the number of bus tickets sold and bus speed and location. It is using the data to help Belfort optimize bus schedules to reduce crowding, determine the savings from new road construction projects, and discover ways to reduce costs.

Senthil Gunasekara, who heads corporate development and strategy for Tata's Digital Software & Solutions Group, said his company developed the lighting and transportation applications as part of a staged rollout of smart city applications on a common software platform.

Adding new application modules enables cities to phase in the expansion of their smart city capabilities within a single platform. The software acts like a lingua franca, enabling it to access, exchange, and analyze different types of urban data, from streetlights and transportation to water and electrical systems.

That is a critical capability because most cities already collect a voluminous amount of information. Much of it comes from sensors and reporting systems that have been in place for years. These range from weather stations and traffic loggers to footfall data and crime videos. The software can integrate this data to help city managers make better day-to-day decisions, and to help them manage emergency response during a crisis.

"It can take data from any source, analyze it, and present solutions," Gunasekara said. "The platform is quite open."

SECURING THE NETWORK

Although cities want an open platform, they also want a secure platform to keep hackers from tampering with urban infrastructure, Ashe said. After all, in a system designed to respond automatically to sensor data, every LED light is also a portal into the city's digital control processes.

Most systems use proven methods to discourage tampering. Predix, for example, monitors individual devices and applications for signs of intrusion. It encrypts communications between devices, networks, and the Cloud. The system allows only authorized users to log in and will shut down any user who tries to do something if he or she lacks permission.

New security standards are emerging to bring better security to every device on the smart network. The recently released ISO/IEC 18598, for example, governs the security of the physical elements of automated infrastructure management systems. AIM components include computers, computer rooms, sensors, devices, cables, and all other hardware.

The standard sets out a list of defined features AIM systems must have, said Hans-Jurgen Neithammer, who led the ISO/IEC 18598 project. He is an expert on data center architectures with CommScope, a New York-based firm that builds and manages communication networks.

Under the new standard, AIM systems must know the location of all devices and cabling, and

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be able to identify and block viruses or intrusions at the level of those components. It must also monitor cable ports for "unauthorized changes," even something as mundane as the accidental disconnection of a cable. "When a critical circuit or element is removed, the system sends an alarm to a manager," Neithammer said.

The new standard also mandates secure but interoperable interfaces for software from different vendors. "The software interface is now defined, so no longer does a user have to rely on one vendor," Neithammer said.

This plug-and-play capability will allow cities to integrate new devices and technologies into existing infrastructure without having to worry about the compatibility of proprietary systems or equipment. "That is the biggest advantage from the user side," Neithammer said.

"Interoperability is really important," agreed San Diego's Graham. It gives the city more flexibility in how it deploys future systems, and it also reduces cost, since it opens the door to greater competition.

Yet smart cities will require significant investments that go well beyond the initial build. With digital infrastructure evolving so quickly, municipal officials will probably need to update software frequently to improve capabilities.

Cities will also need new types of professionals to manage and interpret the data. San Diego, for example, has hired a chief data officer to coordinate the integration of its smart infrastructure with various city departments, and a data scientist to monitor artificial intelligence and other technologies that it may one day want to incorporate it into its system.

Cities will also have to rethink what they know about utility service lifecycles. When a city builds a road or a bridge, it confidently expects it to last for 50 years or more. That is not the case with digital infrastructure.

"Everyone needs to understand the lifecycle," Thompson said. "There's a three-to-five year lifecycle for communications systems."

All of this requires significant investments, yet more and more cities seem willing to take the plunge.

In many ways, they have no other choice. The buildout of a private digital infrastructure points the way toward even greater connectivity, and it is happening rapidly whether cities are leading the way or not.

"Everything is moving toward everything within cities being connected," Ashe said. "In ten years or sooner, autonomous cars will be traveling on city streets and they need to know not only where they are going, but what is coming at them and what is around the corner. Drones will be flying overhead. People will have wearable devices constantly communicating."

Cities must learn to master those flows of traffic, energy, and information to create a smarter city that makes life better for those who are connected and those who are not. Either that, or they will descend into digital—and perhaps physical—chaos as independent smart devices create their own ad hoc networks and fight for their own piece of turf.

It is too soon to tell how this will all work out. Yet one thing is certain: Smart city technology is moving so fast, it has no time to wait for a mock city in the desert. It is happening now. ME

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