Why Smart Cities Need an Event-Driven Architecture

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Businesses and government entities are using smart city technologies to improve targeted operational areas such as traffic management, waste management, parking, smart lighting, and more. While many of these efforts will likely deliver short-term success, the organizations deploying them may be limited in future efforts due to the use of outdated architectures.

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Additionally, the adoption of EDA will allow a transition from current efforts that mostly monitor conditions passively to solutions that incorporate real-time operational intelligence. Such a transition, rather than using historical trends, will allow actions to be taken as situations unfold. COVID-19 has demonstrated the need for immediate actions based on real-time data.

Looking to the future, EDA-powered smart city applications could take things to a higher level, enabling automated response systems in the future.

The Need for a Future-Proof Architecture

The concept, goals, and purposes of smart cities are evolving, requiring a necessary change in thinking about how to plan, develop, and run them. The reason: The promise of smart cities has stagnated due to the use of the wrong tools. Essential to the success of any smart city initiative or effort now and in the future is an open, scalable, event-driven platform that will enable improved city operations and services, while providing a higher quality of life for citizens.

Another important change is that smart cities have typically been envisioned as monolithic entities where data from pervasive sensors is centrally analyzed for a multitude of use cases. Such a concept is changing in that most smart cities will likely be a collection of multiple smart spaces, including smart traffic lights, smart lobbies, smart roadways, smart utilities, smart waste treatment management, and more.

Such smart spaces may operate and be managed independently by different government agencies or private entities. However, there will be many use cases where organizations can realize synergistic benefits if the spaces can somehow be accessed by different entities, or if multiple spaces could work together. For example, a city-run traffic management group and first responders might both want to use a single, smart traffic light system. Or, a hotel concierge might help people manage their stay using both a smart lobby and an autonomous driving system.

These are all areas where EDA can help. While EDA has been around for well over a decade, until recently, it was practiced only within cutting-edge enterprises with the funds, skills, and capabilities to apply the necessary infrastructure of sensors, devices, and processing engines to deliver value.

Now, the rise of smart city applications, the Internet of Things (IoT), and real-time analytics has brought EDA into the mainstream.

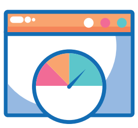
Meeting the Demands of Modern Smart City Applications

Every smart space needs its own data sources, objectives, and analytics. For example, a smart traffic management system might include input from traffic monitoring cameras, embedded road sensors, and traffic volume and speed data from driver cell phones. One city's objective might be to use the data to adjust traffic light patterns to minimize congestion. Another might be to dynamically route first responders along the shortest time to destination routes. Getting to those actions requires aggregation and analysis of all the data sources.

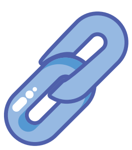
While every smart space has unique requirements, they all share some common characteristics. Namely, they all:

Generate large volumes of streaming events data. Such data must be ingested and analyzed in real time, as it is generated. That data may also need to be saved for regulatory reasons or simply to look for historical patterns or trends.

Use different types of analysis to satisfy different objectives. Actions based on real-time analysis of data streams must be taken in seconds. In that way, decisions can be made, and actions taken in time frames on the order of seconds to minutes. Derived information would then be used for real-time decision support/automation. Data may need further analysis to identify the root causes of common problems.



Will likely be highly distributed and require different data management and compute strategies. Some analyses will need to be done at the edge where the device resides. Some computational work, such as training artificial intelligence (AI) or machine language models, might be best done in the cloud. Again, much of the data generated may need to be retained for trend analysis and to meet regulatory requirements.



Require a level of openness for system integration. A key factor to smart city success will be the ability to coordinate and cross-communicate with different smart systems and spaces. The reason: many applications can offer synergistic benefits if different smart systems can communicate with one another and their information combined and used collaboratively. For example, a utility could make forecasts of customer electrical demands if it integrated information from a smart grid system and a weather application.

Accommodating these factors takes a different type of solution than has been used in the past for analytics and the derivation of business intelligence. In most analytics applications, data is captured and stored in a central repository. Once stored, the data is then analyzed.

It's Not Just the Buildings that Need a Sound Foundation

Smart space applications need an event-driven architecture (EDA) to move beyond traditional systems that monitor conditions and make decisions based on historical data; EDA is designed for a different type of operation. To start, the data includes real-time status information. For example, an embedded sensor might collect the temperature and oil pressure of an aircraft engine. The data is constantly generated. Any change in the state of a measurement is an event.

Certainly, event data can be saved to a database and analyzed later. In contrast, an event-driven application will ingest the data and perform real-time analytics to derive insights into the status of events (e.g., a temperature spike or an oil pressure drop). Identifying that event (the change in the status of the device) as it is happening allows actions to be taken on the spot. Such an approach can be used to examine and take action on a plethora of events data such as clickstreams, real-time financial transactions, and more.

EDAs offer several distinct features or benefits for the types of data and analysis required in smart spaces applications. In particular, EDA supports:

Real-time streaming analytics: EDA is useful when a business requires real-time processing with a minimum time lag. Events occur in a continuous stream as things happen in the real world. Streaming analytics is all about extracting business value from data in motion in the same way traditional analytics tools make use of data at rest. Real-time streaming analytics helps smart space managers by issuing alerts instantly when an issue is detected, or an anomaly occurs. Such information allows entities to take instant action and seize an opportunity that they otherwise might miss.

Asynchronous operations: Asynchronous systems use data that is generated and transmitted intermittently. An example would be a flood watch system that measured a change in water levels. Most of the time, there would be no data, but when there is heavy rain or water pipe breaks, smart devices will convey this information in real time to monitoring systems. As such, real-time applications must be event-driven. The priority is to act instantly on a business event, rather than storing data and checking status later. To ensure any number of events can be acted upon in real time requires asynchronous operations. EDAs are distributed asynchronous architectures that can be used to support highly scalable applications.

Loosely coupled systems: Many smart city applications are comprised of systems of systems. For example, an application to manage traffic congestion might use elements of a city's smart traffic light system and car drivers' mapping apps. Combining information from these separate, yet loosely coupled applications delivers synergistic benefits versus using either alone. Building the individual apps on an EDA would allow the real-time events data from both apps to be used together.

The key to any smart spaces initiative is to use the right technologies that deliver the required results, performance, and scalability for the individual space, as well as allowing smart spaces to work collectively to deliver synergistic benefits. An EDA can use a variety of critical and necessary underlying technologies used in most smart spaces applications.

Use Cases Enabled by EDA

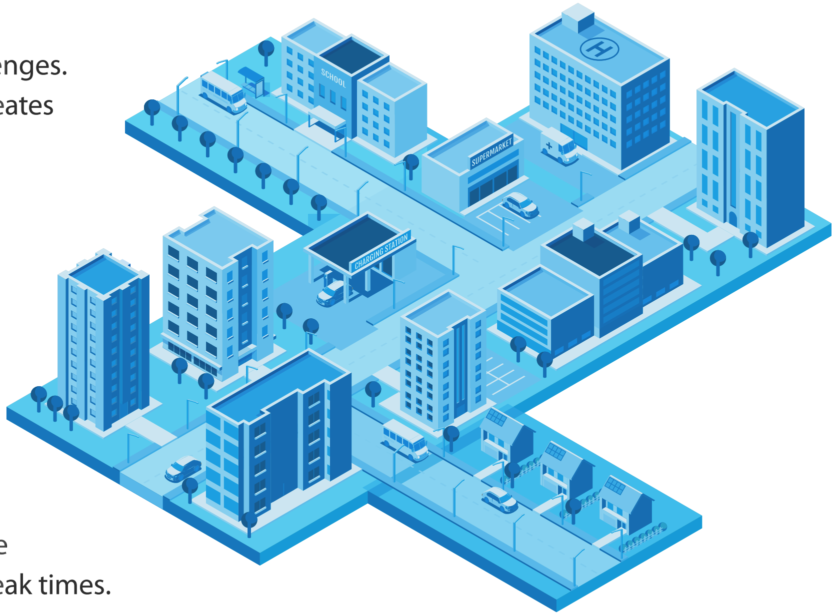
Smart spaces that can make use of these technologies cover a wide range of application areas.

General examples where smart spaces are playing an important role include the following:

Smart buildings. Buildings are incredibly complex collections of systems. Many have separate systems for lighting, temperature control, and fire detection and suppression. Modern and large buildings may also have systems for their elevators and lobbies. Up until now, most smart building models have been used to simulate physical systems and detect issues during the construction process. But an event-driven application with appropriate sensors makes it possible to take the building model and bring it to life for ongoing operational uses.

Smart spaces in hospitals. Hospitals have many systems and operational areas (admissions, patient scheduling, ER, prescription fulfillment, and more) that individually can be made into smart spaces. The true value of using EDA in such an environment is that each smart space can operate as a single entity, and the spaces can work together. Such a collection of loosely managed spaces allows hospital groups to interact and respond to situations in real time.

Smart electrical grid. Utilities face mounting challenges. The variable nature of alternative energy sources creates volatile pricing dynamics, and consumer demand remains highly variable down to the hourly level. Charging requirements for electric vehicles add another element of unpredictability. Fortunately, the wide-scale deployment of smart meters and IoT devices to monitor essential grid elements paves the way to progress. EDA can be used to help grid operators ingest such information and make real-time decisions on when to purchase electricity from third parties, how to maintain their equipment for efficient operations, and how to price their electricity to meet surges in demand during peak times.



Smart airports. Airports combine a variety of services run by public and private entities. Most elements of airport operations are individually and collectively embedding smart technologies. Elements can include airline operations, cargo management, passenger check-in and experience management, ground transportation, and runway operations. Something as simple as knowing where ground service equipment is located can be improved with sensors. Aggregating the information from the various sensors in different systems and performing real-time analysis on the event data they generate can lead to significant improvements in operations, while also enhancing the passenger experience.

How Businesses are Successfully Using EDA

Many efforts to use real-time information to improve operational efficiency and deliver better service are being carried out by government entities. But now many businesses are incorporating the same principles and technologies into innovative smart applications. Some specific examples include:

WaterBit uses an event-driven, real-time moisture monitoring, and water management system to improve crop performance and reduce operating costs. Its solution was driven by the need to solve a simple problem: Growing crops is getting harder as climates change, and water supplies dwindle in many parts of the world. Making efficient use of resources requires real-time insights about soil moisture levels, ambient temperature, humidity, and more.

INESA, a leading developer of information technology, uses an EDA-based smart office solution to monitor 250,000 elevators in Shanghai in real time. The solution provides safety and security to a vast network of elevators. One issue that is unique to this marketplace is that many people would take their motorcycles into office buildings. The smart space solution here uses object recognition of live video streams. Sending the data to a cloud database for analysis would not produce results in time to take action. As a result, the application does the real-time analysis at the data's source (the edge).

Ford Smart Alleyway Project uses EDA to help cities improve waste removal, considering costs and health issues. The project addresses a common problem in many cities: Blocked alleyways that impede waste collection. In many cases, cities pay exorbitant overtime as trucks sit still waiting for cars to be moved, or truck drivers must return to a location after skipping it on their normal route. What's special about this application is that it provides actionable information for waste removal vehicle drivers and city managers by tying together smart data and systems that address congestion, waste service operations, costs (overtime pay), health issues (restaurant waste removal), and policy compliance (illegal parking, idling, and more).

Glotech, a high-end AI company, is building a next-generation EDA-based security system for Capital airport in Beijing, China. It is using digital twins combined with image recognition technologies, both for simulating possible situations and for improving the ongoing operations of the space. Using the smart system, situations can be detected, such as overcrowding, or people located in dangerous or off-limits areas.

Criteria for Technology Selection

Smart spaces need technology to support highly distributed operations, and that lets organizations manage the development, deployment, and updates of any smart solution.

Traditional models for software application design are no longer relevant to the new era of real-time business operations. There is now a need to develop entirely new applications that are real-time in nature. Most efforts to develop new or transform old applications into real-time have failed since the database-centric architecture used for years is not the appropriate architecture for real-time applications. As a result, a significant number of modern, event-driven systems are now being built that sense, analyze, and take immediate action on the events that are occurring in and around the business in real time.

Implementing a real-time event-driven platform requires skills and technology that many companies simply do not have the expertise in using. As a result, many companies are looking for technology partners that can deliver expertise, deep industry knowledge, real-world best practices, and solutions for real-time applications.

A suitably selected EDA platform offers some distinct features and benefits. The right platform will enable the transition to today's real-time, information-driven world. Using such a platform, organizations can develop applications to analyze how events are occurring and changing, in time and space, in real time. The solution lets organizations incorporate technologies such as AI, IoT, and blockchain with legacy systems.

Applications built using a modern EDA platform would include facility security (using AI and facial recognition technology), field service management (using real-time location tracking), logistics and supply chain management (using IoT sensors and GPS), and many more.

EDA platforms, such as VANTIQ, have taken this a step further by incorporating low-code tools to enable the development of these applications. Such applications are highly customized to the specific needs of a smart space organization and can be built in days or weeks—not the months or years it would normally take.

Using such an EDA platform, organizations can rapidly develop and deploy real-time applications. Essential attributes include:

- Low-code for the rapid development of event-driven applications
- An agile, event-based integration model
- Edge and event-mesh deployments
- Collaboration models for human-augmented automation
- An enterprise-ready platform that supports scalable, federated, encrypted, mission-critical applications

How VANTIQ Can Help

Such features and capabilities are well-suited to the demands of smart spaces and smart cities. These are all areas where VANTIQ can help. The heart of the VANTIQ offering is an event-driven architecture that focuses on the generation and handling of event notifications. Using such an event-driven architecture, smart space planners, developers, and managers can develop next-generation smart city applications that make use of event data to take real-time actions. The solution also offers the flexibility to accommodate changes, scale as needed, and sustain performance while data analysis requirements grow exponentially.

To learn more about building smart spaces based on an event-driven architecture, visit: https://vantiq.com/.

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