WHITE PAPER

Becoming a Smart City

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Contents

The Smart City

New, improved and emerging technologies are changing the way cities and counties operate. When a city uses information technologies to better govern and serve its citizens, it's referred to as a "smart city." In smart cities, governments use technologies such as the Internet of Things (IoT), communications, social media, data storage and analytics to proactively solve problems, maximize organizational effectiveness and efficiency, and provide higher-quality service to citizens.

However, information technology projects present new data management, integration and cost challenges to local governments. Consider the need to analyze ever-growing amounts of data streaming from sensors in devices such as streetlights, water meters, public transportation systems and more. Cities can overcome these challenges by establishing a strong analytical backbone – including a centralized data store – as the framework for city government.

For smart city initiatives to be successful and deliver expected benefits, elected leaders and their staffs need a clear and agreed-upon vision for the initiative and an approach that fits their capabilities and needs.

The Strategic Role of Technology in Smart Cities

Today's city officials face changing populations, increasing government regulations, decreasing tax base growth, aging infrastructure and constrained budgets. At the same time, citizen expectations for service delivery are rising dramatically. People are accustomed to using computers, the internet and cellphones for convenient access to information, quick action and immediate problem solving. They expect the same type of service from the governments that serve them. Citizens want and expect cities to use technology in ways that make services more effective, efficient and responsive.

Technologies such as the IoT, telecommunications, social media, cloud-based data storage and advanced analytics help city officials meet these challenges – enabling them to deliver innovative services, support higher service levels and do more with less. But these technological advancements also create a new set of challenges – particularly around data's explosive growth. According to many sources, the size of the digital universe will double every two years.[1] Cities are contributing to this trend, generating vast amounts of new data in departments as varied as planning, utilities, public safety, education and finance. As data continues to grow, it becomes increasingly important for cities to quickly integrate and manage it all – including data created by IoT devices.

[1] Source: The Exponential Growth of Data, insideBIGDATA.

IoT and Telecommunications

Software has evolved from being inside a computer to being embedded in all types of everyday objects that collect and communicate information – such as meters, sensors, cellphones, vehicles, buildings and machinery. Consider streetlights, which were previously inert and noncommunicative. Now they can contain electronics, software, sensors and network connectivity that allow them to collect data on traffic and send it for near-instant analysis. Such connected objects can be accessed, metered and controlled remotely through a city's network infrastructure. The data streaming from these connected "things" can also be integrated with the systems cities use to manage the business and run operations. Analyzing this combined data gives cities even deeper insight into which actions are best suited for the moment.

As cities strive to provide the best levels of service and infrastructure for the least possible expense, the IoT can play a vital role. For example:

- Cities are using sensors at intersections to monitor congestion and communicate to software that adjusts signals in real time to reduce congestion.
- Automated meters gather water and electricity consumption information and send it to databases for analysis at regular, frequent intervals. This enables cities to understand and influence utility consumption.
- Location data collected from cellphones is enlightening city planners about how citizens typically move in and around the city.

The Internet and Social Media

Just as connected objects, devices and machines are collecting copious amounts of new and useful data, people are also generating data. For example, people freely provide information about themselves through their internet inquiries and purchases – information that companies can analyze to gain insights about them. Similarly, as people share their thoughts, preferences, dislikes and concerns on social media, those personal sentiments become data, which can be collected, retained and analyzed by cities to understand trends, identify issues and make better decisions.

Cloud-Based Data Storage

Because cities are collecting data faster than ever, they are creating and accumulating massive volumes of data that must be securely stored, managed and accessed. Cities can store their vast collection of data in off-site, internet-accessible storage, often referred to as the cloud. This storage is secure and scalable. Because cities are essentially renting data storage when using cloud storage, they can use their operating budget to pay for it (rather than spending capital budgets to buy equipment).

One of the biggest benefits of cloud-based storage is its flexibility regarding storage and computational power, as both can scale on demand to meet an organization's needs. Cities no longer need to buy more space or processing capability than needed, nor are they at risk of running out of space or running slower due to inadequate space or processing capacity. In addition, using cloud-based storage reduces the cost and hassle of maintaining and running municipal servers and databases; cloud-hosting companies take care of database maintenance, backups, security and data movements for their customers.

Analytics

Once data is stored, city governments can use sophisticated analytics software – which employs a variety of statistical analysis methods and algorithms – to turn that data into valuable insights. High-performance technology processes the data at up to millions of events per second. And it quickly sifts through incredibly large volumes of information to identify correlations and trends – work that would take humans many weeks to perform.

Using advanced analytics, cities can equip decision makers and service providers with the intelligence they need to make fast, data-driven decisions. This can give cities insight into what happened and why, and it can determine future outcomes and trends (see Figure 1). Armed with this knowledge, a city can more accurately predict the impact of specific actions – for instance, locating a police substation in different parts of the city, or providing more resources for certain high-demand citizen services.

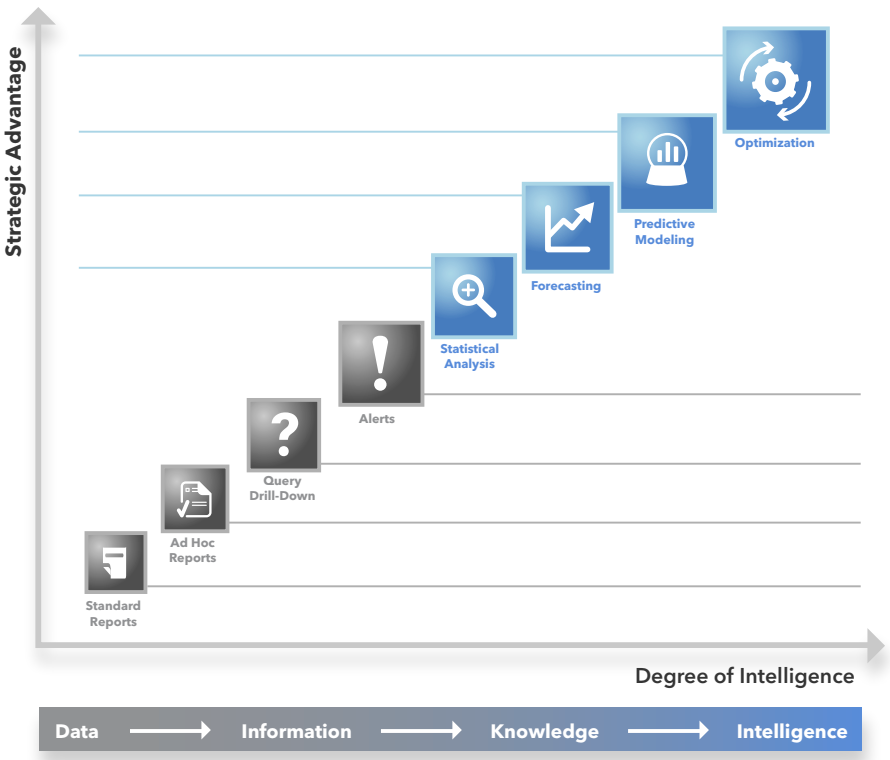

Figure 1: Advanced analytics can provide insight into what happened, why it happened, and even what will happen.

When analytics is used with IoT data, it's referred to as IoT analytics. In some cases, analysis takes place at the device or sensor – a technique known as edge analytics or streaming analytics. IoT analytics technology can help cities reduce costs and improve transparency by enabling them to collect, manage and analyze data at the source – from numerous connected devices, machines and systems. The data does not have to be sent to a central database before it's analyzed, which helps address latency and bandwidth concerns and enables cities to take immediate action when needed. One way some cities use IoT analytics is to determine precisely when assets or infrastructure (such as water pumps or bridges) need maintenance or operational changes to prevent failures and service disruptions.

A smart city solution has three characteristics: It collects data, analyzes it and uses it to improve city services and infrastructure. The essential element is analytics – without it, the true value of IoT cannot be realized, the breadth of information produced by social media cannot be tapped, and a city's operational and infrastructure data cannot be used to identify opportunities for improvements and efficiencies.

While smart cities promise tremendous value, governments can achieve significant gains from analytics technology before fully implementing a smart city solution. Consider the large volume of data residing in the software systems and databases that various city government departments use. Data management and analytics alone can provide incredible value by combining this disparate data and revealing findings that help individual departments use their data better. For example, a city may be able to combine its police and code enforcement data to better understand the relationship between crime and property neglect.

Overcoming Smart City Challenges

Cities face several challenges as they embark on smart city strategies – particularly with the deployment of new technologies. Specifically:

- Cities are accustomed to working in a decentralized environment in which departments work independently from one another. This independence breeds duplicate data collection and makes it nearly impossible to identify correlations between work done – and data generated – by each department.
- Smart city solutions usually require different vendors – hardware, telecommunications and analytics software companies – to work together.
- Analytics talent is in short supply – and local governments may find it hard to compete with the private sector in attracting highly skilled analysts.
- Cities may be overwhelmed by the cost of implementing new technologies.

Centralizing data storage requires a clear set of data governance policies, which are documented guidelines and rules for the proper creation and management of digital information. Such guidelines can involve policies about the processes used in the office, as well as security, consistency, data quality and privacy. For example, a rule could require street names to be recorded as "St" rather than "Street," "St.," "STREET" or "ST." These rules facilitate the consistent naming of objects, people and events; prevent duplication of records for the same person, place or thing; and allow search engines to find all data related to a search topic.

Standardizing how different data is stored in a database is part of the data cleansing process.

Once data is cleansed, analytics users can generate more accurate, trustworthy and complete analyses and reports. For example, when someone queries a property in the centralized database, they have confidence that the system will find all information from every department about that property; nothing will be overlooked because records were accidentally stored under a different name. And data rules and guidelines will help ensure that data gleaned from future software installations will be formatted properly.

Creating an Analytical Framework

So how can city governments get started on their own smart city journey? By developing an analytical framework. Due to resource and cost hurdles, most cities have to take a staged approach to this – and that requires adopting multiple, smaller, easily integrated smart city projects over time. This will ultimately enable access to, and analysis of, all data across the organization.

Step 1: Set the Vision

The adoption of any smart city solution begins with leadership. Cities in which leaders aspire to use technology to provide the best quality of life for their citizens are well-positioned to embark on smart city solutions.

To create a framework for analytics, it's critical that city leaders understand and believe in the long-term value of using analytics across departments and divisions to optimize services and infrastructure. They must also understand how using analytics will enhance residents' lives. With an articulated vision from elected officials, city managers are positioned to investigate technology solutions for the problems they face.

Many governments find that the best approach is to "think big but act small." Implementing analytics incrementally is not only more financially feasible, but it introduces leaders to the benefits of combining diverse data sets to better understand what is happening in the organization, and why, along with what might happen and what could happen if operations were changed. Practical findings from analytics will likely inspire further use of analytics.

Step 2: Select Projects

When determining which smart city solutions to pursue, decision makers should evaluate options based on:

- The importance or criticality of the issues they resolve.
- The amount of data already collected around the issue.
- The cleanliness (and thus the readiness) of that data.
- The expected return on investment from resolving the issue.

For cities working toward establishing an analytical framework, each project is one more step toward building the framework.

Many governments find that the best approach when getting started is to "think big but act small."

Step 3: Evaluate Data

Cities often have more data stored than managers and even their supporting IT resources know about. For each proposed project, it is important to identify:

- Where related data is stored.
- The quality of that data.
- How the data was generated (for example, was it entered by a person, automatically generated by a meter, or collected from the internet?).
- Whether the data exists solely in primary databases, or potentially other databases.

Based on answers to these types of questions, decision makers can determine if they have the appropriate data collected and available to take advantage of a given solution. If they don't, they can take steps to deliberately collect the necessary data, or choose to postpone the project until they are ready to do so.

Step 4: Determine the Best Approach

The approach taken when implementing an analytics solution varies with the type of solution. As shown in Figure 2, solutions typically fall into three categories:

- Results-as-a-service solutions.
- Task-specific solutions.
- Enterprisewide solutions.

For each solution, the cost, required implementation resources and output can vary considerably.

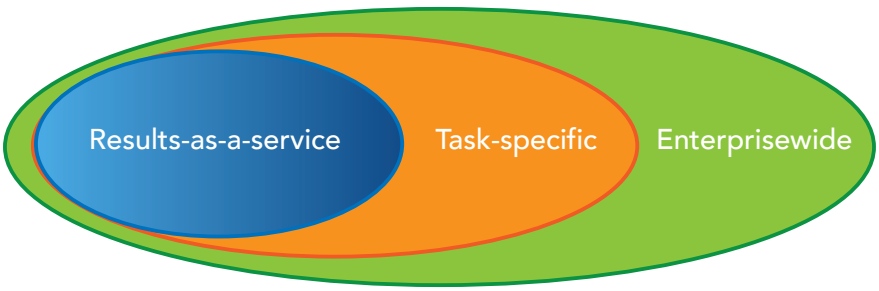

Figure 2: Smart city analytics solutions typically fall into three categories.

Whether a city has too much or too little data, analytics helps it be more effective in collecting and using the data.

Results-as-a-Service Solutions

In a results-as-a-service solution, decision makers for a city identify a question to be answered or a problem to be solved. An analytics company integrates and analyzes disparate data provided by decision makers to offer a one-time answer or solution. For example, an EMS organization wanted to know the optimum amount of time to deliver CPR to cardiac arrest patients to realize the best survival rates. Analysts collected and analyzed the organization's data and delivered an informed recommendation, which the EMS adopted as its new protocol.

Task-Specific Solutions

In a task-specific analytics solution, the city government needs to solve a specific problem or perform a specific task. In this case, the city provides access to data from the relevant part of the organization. The analytics company integrates the data and provides software to analyze it. While the data may be stored on-site in the city's offices or hosted by a third party, the city will take responsibility for using the software. City employees will continue to enter new data and analyze it on an ongoing basis.

For example, a city's public works department can implement analytics software to understand water consumption and forecast the need for additional utility expansions. Information from customers' water meters is captured hourly by sensor devices and stored in a database. This IoT data is combined with other data and analyzed using analytics software, enabling city officials to understand peak demand; predict how

population growth, weather events and other factors will influence consumption; and determine the optimal timing of plant expansions. In this example, the solution is isolated within the public works department. If the city's police department wanted to begin using analytics, the city would embark on another task-specific software solution to gather and analyze that information.

Enterprisewide Solutions

Many cities embark on multiple, task-specific projects as a way to gradually move to an enterprisewide approach to analytics, complete with a centralized database and enterprisewide analytics framework. These city governments intend to manage data across departments, analyze the data in and across their departments and drive adoption across the enterprise. Over time, the city feeds data into the central database and enlarges the reach of its analytics toolset. Cities are ready for this approach when they can hire a staff of data analysts or fund a third-party analytics team to assist employees in using analytics to solve problems or perform tasks.

Data management is the most laborious and time-consuming aspect of a data analysis project. As the old term goes, "garbage in, garbage out." To have comprehensive and defensible findings, the analytics software needs quality data as input.

Step 5: Perform Data Management

The majority of analytical work lies in the preparation of the data, which may come in diverse formats from many systems and may apply vastly different conventions to each data element (as illustrated by the prior "St" versus "Street" example). The object, person, place, event or occurrence about which data is collected is called the "entity." For example, "citizen" may be an entity in a city's database. An individual citizen's name and Social Security number are data elements that describe a given citizen.

When integrating data from different sources (such as databases from different departments), the data elements must be reconciled and made consistent so that there is a consistent record for the entity across databases. For instance, a citizen's proper name may be "Kathryn Johnson" but may be recorded in police and public works databases as "Katie Johnson" (her nickname) and "Kathryn Wallace" (her maiden name). Before analyses can be run, data sources and elements (such as citizen names) must be combined and reconciled. One way to speed this process is by using self-service data preparation software tools designed specifically to help individuals prepare data for analytics quickly, without an IT or data specialist.

Over time, city government staff and elected leaders can evaluate the benefit of their analytics investment for their community. Very often, the results derived from one solution will inspire the city to embark on using analytics software to solve other problems.

Step 6: Employ Analytics

As noted earlier, analytics solutions can be delivered as services that provide one-time answers to questions; these solutions can be tailored to specific tasks or issues, complete with ready-made reports for decision makers to consume. Alternatively, cities may choose to acquire analytics software packages that allow them to freely explore their data on an ongoing basis. In other cases, a city's analytics solution may include both of these elements. It all depends on the approach a city takes.

Be Prepared for Your Smart City

With the proper vision and support – along with a flexible analytical framework that can expand over time – governments can establish a strong foundation for both short- and long-term smart city initiatives. Thinking big and acting small allows governments to weigh which IoT projects make the most sense for their resources and pressing citizen concerns. Find out how SAS can help you build a smart city, step by step. Visit: sas.com/iotsolutions.

To contact your local SAS office, please visit: sas.com/offices