Understanding Smart Cities from the Geospatial Perspective

a guide to getting started

Background

The North Carolina Geographic Information Coordinating Council (GICC or "Council") was established by the NC General Assembly to develop policies regarding the use of geographic information, geographic information systems (GIS), and related technologies.

The GICC achieves its goals through collaborative leadership, communication, and assistance. Leadership includes promoting geographic information system (GIS) technology for the state and demonstrating the value of reliable geographic information for effective decision making. The Council supports communication by providing opportunities to examine issues, share ideas, and build consensus through collaborative activities. Assistance consists of standards and recommended practices, guidelines and policies, learning opportunities, and projects and initiatives that expand and improve public access to complete, consistent, current, statewide geographic information. The Council's structure includes the GIS Technical Advisory Committee (TAC). The Technical Advisory Committee reviews and recommends best practices related to hardware, software and database standards. The TAC originally published this document in the Sumer of 2019.

Objective

The objective of this TAC document is to inform North Carolina local governments that are engaged in or preparing to start a Smart Cities initiative to improve public services. The approach is to describe basic Smart Cities concepts, approaches, practices and the role of geospatial data and technology.

The intended audience for this document is local governments in North Carolina that have collected or are planning to collect data in support of a Smart Cities initiative and are considering next steps. Lessons learned by early adopters of smart technologies are intended to guide municipalities and other local government entities.

What is a Smart City?

For the purposes of this document a Smart City is defined as an urban area that use a variety of electronic data collection systems to inform and optimize management of assets and resources. This includes data collected from citizens, devices, and various assets such as utility meters. Data may be processed and analyzed to monitor traffic, manage transportation systems, power plants, water supply networks, waste management, public works, law enforcement, information systems, schools and/or other community services. Terms that may be associated with the concept of a Smart City include livability and sustainability. Geospatial information adds value by enabling the analysis of "where."

Techopedia defines a Smart City as "a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation, and utilities in order to reduce resource consumption, wastage, and overall costs. The overarching aim of a Smart City is to enhance the quality of living for its residents, business owners, students, and visitors through smart technology.

TABLE OF CONTENTS

1. Examples of Smart City Initiatives in North Carolina

City of Winston-Salem

Winston-Salem has implemented several technical solutions that relate to Smart Cities. For example, the City utilizes an Automatic Vehicle Location (AVL) solution in over 1,100 City vehicles, collecting vehicle and driver related data.

Regarding the Internet of Things (IoT), Winston-Salem has over 120 miles of City-owned fiber installed within its city limits, with 12 hub sites and off-shoots to multiple other City facilities. This fiber will allow the City to distribute many types of IoT devices for future data collection. One activity that is already leveraging the fiber is the installation of security cameras downtown. The City is also looking into cameras to assist with parking, traffic patterns, and pedestrian traffic. Winston-Salem has security cameras installed in multiple facilities and the downtown area. A management platform enables the City to assign access of various cameras to staff on an as-needed role and basis. The platform will also allow the City to temporarily 'deputize' private cameras, enabling police officers to see camera footage from private citizen and business cameras as needed.

The Winston-Salem Department of Transportation (WSDOT) and the NC Department of Transportation (NCDOT) have numerous traffic cameras distributed around the city. WSDOT pushes traffic data to WAZE for a view of traffic for their end-users. Similarly, Greensboro pushes planned road closures to Waze.

Winston-Salem uses beacon technology at the Bowman Gray Stadium and Fairgrounds for sharing information with event attendees and collecting information about attendees and their location.

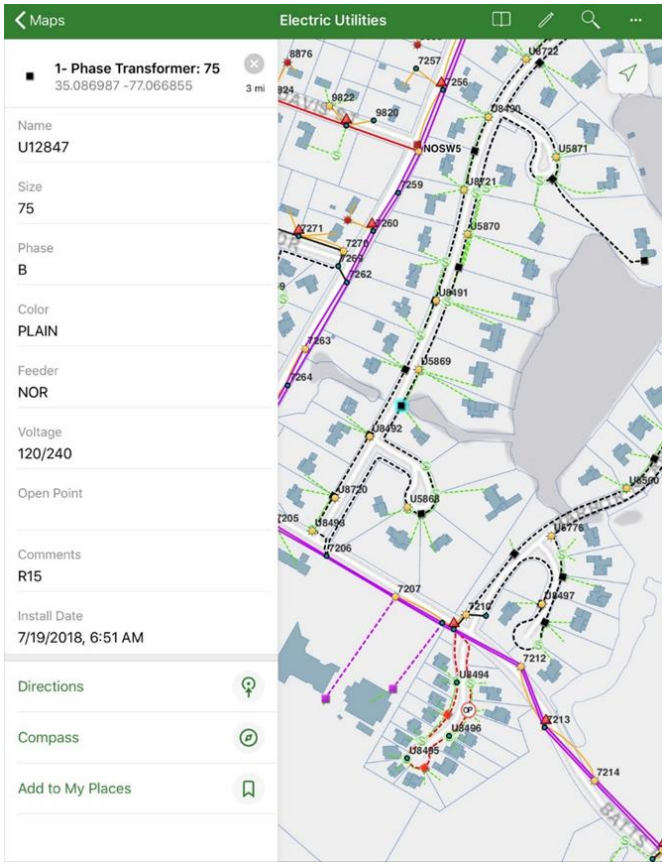
The Winston-Salem/Forsyth County Utilities department collects real-time information from various pump stations around the county for operations management. The department has a very large and active Advanced Metering Infrastructure (AMI) project that will include building some form of network grid/mesh around the county to collect water consumption and other data from over 120,000 water meters.

City of New Bern

The City of New Bern's Advanced Metering Infrastructure (AMI) (water and electric) is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers. The system provides important functions that were not previously possible or had to be performed manually, such as the ability to automatically and remotely measure electricity use, connect and disconnect service, detect tampering, identify and isolate outages, and monitor voltage. Combined with customer technologies, such as in-home displays and programmable communicating thermostats, AMI also enables utilities to offer new time-based rate programs and incentives that encourage customers to reduce usage during peak demand and manage energy consumption and costs.

In New Bern's live outage map the general public can see real-time power outages and report an outage. Now users do not need to call the City to find out about power outages. During Hurricane Florence this allowed staff to work on other response activities.

It is hosted by dataVoice International, which works in conjunction with New Bern's GIS layers of electric data as well as its new AMI meters, of which 95 percent of the City and service area have been converted.

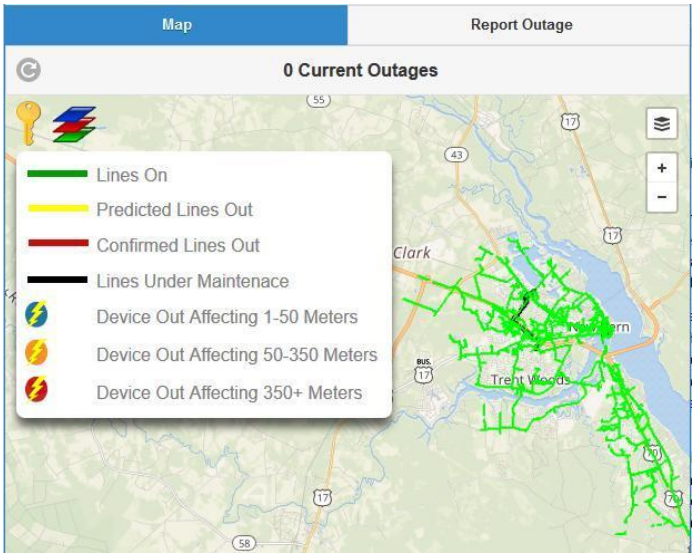


The AMI allows the City to have real-time reading of both water and electricity throughout its service area. It allows for two-way communication between the meter and the electric department. If any meter is down along a service line, the system will send a signal that there is an issue and what features or service connections from that issue will be affected. Though it can't tell exactly what the issue is, it can report the severity. This saves the City an enormous amount of time trying to pin down issues which otherwise would require sending out workers in all types of weather and time of day.

It also saves time and is safer than having meter readers stop at each location to read meters. AMI is more accurate in meter readings and can be set to alert for such things as a spike in usage, which can trigger a review for leaks or other issues. It saves time in trying to resolve issues and fix problems. AMI is also capable of performing detailed analysis so the City can map out hot spots of use and better plan for updates and growth.

Citizens like AMI because of the accuracy and ability to get detailed use analysis. This enables them to make more informed decisions when setting up equal monthly payment options versus paying more during spikes of hot or cold weather. They are also made aware of issues by looking at the map, negating the need to call in to report an outage and the City staff returning the phone call when the power is back on.

During Hurricane Florence all services were lost. AMI allowed precise dispatching of crews for repairs that would restore the most customers in the quickest manner. Using GIS and an application called LinemanApp, utility workers in the field could interface with the Outage Management System (OMS) and see major circuits and devices which allowed for faster and more thoughtful restoration of services. This allowed for a 50% restoration of electrical services with a short 24 hr time frame and 98% within days after the storm.



The online map was viewed thousands of times as people anxiously waited for service to be restored. Citizens could see what areas had service. The system greatly aided those many agencies that came to assist in service restoration. Using the AMI system, crews could determine where the service restoration would be most beneficial for the highest number of customers, and how quickly it could be done. This removed the need for them to physically check-in to see where they needed to deploy.

2. Open Data – Public Access to Government Data

The concept of Open Data applies to geospatial data in general and data collected by Smart City initiatives specifically. Open Data are freely available to everyone to use and publish as they wish, without restrictions from copyright, patents or other mechanisms of control. For the Smart City, the role of open data is as an enabler of innovation. This includes but is not limited to geospatial data. Open Data places information in the hands of the residents of Smart Cities who need it to solve problems. Open Data projects hold great potential to provide citizen-centric solutions and optimizing Smart City services according to the needs and preferences of citizens. While many Smart City solutions come from the top down, Open Data lets solutions come from the bottom up.

The benefits of Open Data for Smart Cities include: Increased transparency and accountability, develops trust, credibility, and reputation, promotes progress and innovation, encourages public education and community engagement.

The NC Department of Environmental Quality (DEQ) has been recognized for their Open Data site: http://data-ncdenr.opendata.arcgis.com.

3. SMART CITY CAUTIONS

The Smart City vision is based on urban planning ideals that have evolved over more than a century. However, there are cautions, criticisms, and potential unintended results to consider. Conceptually, Smart City initiatives tend to be based on top-down urban governance using new technology. Cities need to distinguish between visionary solutions and marketing or branding of technical solutions. Investments in arrays of sensor networks and supporting collection and analysis tools can require enormous government contracts. Note that many of the phrases leading to the term Smart City - "smarter cities", "connected cities", "digital cities", etc. - are copyrighted by corporations like HP, CISCO, and IBM.

Another caution related to Smart Cities is the extent of data collection and analytics in the context of privacy concerns. Collected data and its uses need to be transparent and open to public access or scrutiny. For example, San Diego faced a public backlash when it was revealed that a network of smart streetlights included cameras that police were using to watch citizens. Ultimately, the cameras were removed. In another example, applications of Artificial Intelligence for predictive policing may exacerbate bias in law enforcement.

There may be unintended consequences to integrating private technology entities in municipal operations in Smart City implementations. Cities risk giving "an incredible amount of control [to] tech companies ... that certainly don't have the same general interest as what their governments should be focused on," said Ben Green, a fellow at Harvard's Berkman Klein Center.

Smart Cities can also tie the hands of government via vendor lock-in, a risk for any information technology implementation. Smart Cities bear the additional risk of proprietary AI algorithms used to make policy recommendations that may not be auditable by the government or its citizens. Open Data, open AI models, and careful consideration of exit costs should be of primary importance when entering into Smart City contracts with vendors.

4. THE ROAD AHEAD

Profound technological advances emerge and become integrated with other technologies at accelerated rates. Computing power increases exponentially while the physical size of hardware shrinks exponentially. A myriad of sensor types (cameras, radar, LiDAR, etc.) also increase capabilities exponentially. Autonomous vehicles appear likely to suddenly emerge in the same way the iPhone was introduced in 2007—within a couple of years smartphones became indispensable to nearly everyone.

How can Smart City innovators plan for, rather than react to, reasonably predictable advances? As a transportation example, in five to fifteen years, will self-driving vehicles and "transportation as a service"

via ride-hailing applications change the analysis of the costs and benefits of a prospective urban rail system?

As of 2019, Smart City initiatives are just getting started in North Carolina. The Technical Advisory Committee invites local government GIS and Information Technology professionals to share knowledge of and experiences with Smart City initiatives. This document may be expanded as technology changes and local government strategies, policies, and lessons learned emerge.

5. Key Terms and Definitions

This section is used to orient GIS professionals to terminology related to Smart Cities, then describes examples, elements, and issues to consider.

Artificial Intelligence (AI), particularly machine learning, is often used in Smart Cities, building mathematical models from collected data in order to make predictions or decisions without being explicitly programmed to perform the task.

Advanced Meter Infrastructure (AMI) - Advanced Metering Infrastructure (water and electric) is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.

Automatic Vehicle Location (AVL) is a means for automatically determining and transmitting the geographic location of a vehicle. This vehicle location data, from one or more vehicles, may then be collected by a vehicle tracking system to manage an overview of vehicle travel.

A ***Connected Device*** (or smart device) is an electronic device, generally connected to other devices or a network via the internet.

Enterprise Asset Management (EAM) - involves the management of the maintenance of physical assets of an organization throughout each asset's life cycle. EAM is used to plan, optimize, execute, and track the needed maintenance activities with the associated priorities, skills, materials, tools, and information. This covers the design, construction, commissioning, operations, maintenance and decommissioning or replacement of plant, equipment, and facilities.

Information and Communication Technologies (ICT) is the term to include all devices, networking components, applications, and systems that combine allow people and organizations to interact in the digital world. ICT is an extensional term for information technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage, and audiovisual systems, that enable users to access, store, transmit, and manipulate information.

Internet of Things (IoT) is the network of devices, vehicles, and home appliances that contain electronics, software, actuators, and connectivity which allows these things to connect, interact and exchange data. Reference: https://en.wikipedia.org/wiki/Internet_of_things. IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones, tablets, to any range of traditionally non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

LoRa is a long range, low power wireless platform that is the prevailing technology choice for building Internet of Things (IoT) networks worldwide. LoRa devices and wireless radio frequency technology (LoRa Technology) are used in a lot of Internet of Things (IoT) networks worldwide. LoRa Technology enables a variety of smart IoT applications aimed at solving challenges like energy management, natural resource reduction, pollution control, infrastructure efficiency, disaster prevention, and more. LoRa's long-range wireless communication protocol competes against other low-power wide-area network (**LPWAN**) wireless technologies.

Low-Power Wide-Area Network (LPWAN) is a type of wireless telecommunication wide area network designed to allow long range communications at a low bit rate among connected objects.

Near-Field Communication (NFC) is a set of communication protocols that enable two electronic devices, one of which is usually a portable device such as a smartphone, to establish communication by bringing them within 4 centimeters of each other.

Open Data is data that is freely available to everyone to use as they wish, without copyright, patent, or other restrictions.

Platform as a Service (PaaS) is a category of cloud computing services that provides a platform allowing customers to develop, run, and manage applications without directly managing IT hardware.

Siloed Cities have poor integration between different city responsibilities, across departments, amongst communication networks, and with other regional governments.

Smart Infrastructure refers to the integration of smart technologies into the fundamental facilities and systems serving a city, country, or other areas including the services and facilities necessary for its economy to function.

A ***Smart Meter*** is an electronic device that records consumption of electricity in intervals of an hour or less and communicates that information back to the utility for monitoring and billing.

Smart Parking is a vehicle parking system that helps drivers find a vacant spot using sensors and communications networks.

Structured Data follows an abstract model that organizes elements of data and standardizes how they relate to one another and to properties of associated real-world entities.

Unstructured Data is information that does not have a pre-defined data model.

An ***Urban Data Platform*** provides a common digital environment for the aggregation of data across multiple city responsibility areas and departments

(Several terms and definitions are from https://rg.smartcitiescouncil.com/master-glossary.)

6. Reference Documents

- Smart Cities Readiness Guide glossary
- SmartCitiesWorld whitepapers
- Smart City, Wikipedia

- Open Data, Wikipedia
- Advanced Metering Infrastructure and Customer Systems, US Dept. of Energy
- The Trouble with Smart Cities, Erica Pandey, Axios
- Why Smart City Failed, Ferdor Novikov, Medium
- Predictive Policing Reinforces Police Bias, Kristian Lum, Human Rights Data Analysis Group
- Does Predictive Policing Lead to Biased Arrests? Results from a Randomized Controlled Trial, Statistics and Public Policy Journal
- Open Data Policy Guidelines, Sunlight Foundation
- Benefits of Open Data, European Data Portal
- Benefits of Open Data for Smart Cities, bee smart city
- Open Data and Smart City KPIS, Daniel Sarasa, Open Your City
- Best Practices/Commercial Considerations for Open Data Portal Design, W3C
- Publishing Open Data – Do you really need an API?, Peter Krantz
- What's so hard about that download?, Paul Ramsey
- Boston Smart City Playbook
- Noteworthy Smart City initiatives: San Diego, Denver, Portland, and other city initiatives