Executive Brief

Smart City Technology: Collaboration and the Digital Twin

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Ruthbea Yesner   Curt Savoie
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IDC OPINION

The impact of rising urban populations has driven the adoption of the Smart Cities concept to prioritize the use of digital and technology innovations to address long-standing urban challenges. Digital innovation is a topic of growing importance as projections for water resources, energy use, and other key services become more dire. For example, the global demand for water is set to increase 55% by 2050, and the global demand for energy is expected to increase 28% by 2040. These challenges exist within the context of already strained municipal infrastructure; road congestion rises each year and housing costs soar in urban areas. At the same time, technologies such as videocameras, sensors, and other devices are collecting more information about cities, and at very granular levels. This data can be used to help plan for, and mitigate, the impact of urban population growth and to improve urban resilience.

These technologies offer a world of increasing data opportunities but also increasing data complexity. As a result, robust tools that can support more sophisticated, collaborative planning are critical for municipal organizations. Urban planners, emergency management, transportation agencies, and executive leadership must be able to share and process information quickly to respond to events. This requires information to be presented in a way that is immediately understandable and actionable.

Digital twins are a technology solution designed for the collaborative use of complex data. They help address the following challenges:

- Data is becoming larger and more complex while being generated at a faster rate.
- Cohesiveness in an organization is hard to achieve without a shared version of the ground truth from which to build actionable consensus.
- The rise in connected devices allows cities to take a holistic approach to addressing issues at both the neighborhood level and the citywide level. Systems thinking approaches become more necessary to solve the critical issues of the day.

Digital twin technologies represent a piece of the next step in the evolution of complex information presentation. For cities to be more resilient, they should consider the power that virtual twin simulations offer to see and ultimately transform the future. "What if" scenario planning can be a key difference in preparedness levels; using virtual and augmented reality to enable robust "what if" planning makes it possible to see multiple potential futures, test their consequences and implications, and then work to build the best possible future.

IN THIS EXECUTIVE BRIEF

This IDC Executive Brief discusses digital twin technologies and their place in an organization's ecosystem of analysis, planning, and collaboration tools. The document answers the following questions:

- What is a digital twin?
- What is the current state of this emerging technology?
- What does the future hold for this next-generation platform in Smart Cities?

The challenges in preparing your organization for any new data initiative can be daunting; data can be messy, engineering resources scarce, and budgets limited. Having a vision and a clear sense of the key problems can make all the difference in picking the right approach and aligning resources to achieve success.

TECHNOLOGY AND SITUATION OVERVIEW

The digital, or virtual, twin is a solution-based approach capable of producing high-fidelity copies of a city or other geographic space. This digital copy is based on a wealth of potential data sources such as GIS base layers, IoT sensor data, historical data sets, and other Smart City sources such as crime data and multichannel nonemergency citizen reporting systems like "311" systems, environmental monitoring, planning and permitting, and transportation infrastructure. Bringing together this breadth of information in a three-dimensional (3D), high-fidelity, single source of information enables organizations to conduct better analysis and more accurate scenario planning.

At its heart, the digital twin is all about data combination and collaboration functionalities within a centralized referential. While storing data is often easy, utilizing data to its fullest potential is time consuming. Cleaning, processing, acquiring, and presenting high-quality data can require large amounts of technical know-how and stakeholder buy-in to get to sufficient usability. Local government organizations have a multitude of data, but often the data is not easily shared or combined, especially across departments that may use different systems and collect and store data in variety of different formats. This makes planning and scenario modeling/what-if scenarios more difficult because scenarios (e.g., traffic planning in case of an emergency or the impact of a storm surge and rising water levels) aren't limited to data held within one group in a city. The power of the twin is in its data integration, visualization, and collaborative functions used in combination. Bringing the data into a single platform capable of visualizing it in sophisticated ways using 3D modeling makes the information instantly understandable and usable by a wide variety of stakeholders. As the saying goes, seeing is believing, and these kinds of models take that to a new level. Good collaboration is all about bringing stakeholders together in a way that allows them to see and work with a validated and shared single version of the truth, especially if it is distributed and accessed in a federated way across multiple sites and departments. Without this collaboration, finding good solutions becomes almost impossible. When working on a solution as a team from agreed-upon ground truth, everyone starts from a stronger position to move quickly and effectively.

The scenario planning and hypothesis testing capabilities of the technology will continue to increase as platforms develop and new data is added. Providing stakeholders, government agencies, and urban planners with the ability to "play through" a scenario and see the impact of different variables on the urban ecosystem as a whole was extremely hard for most data analysis and visualization technologies. Having data-driven insight into potential solutions and places of opportunity and giving that insight to

agencies will make programs targeting those particular areas of need much more effective overall. Being able to formulate questions and then test hypothetical scenarios, such as what will happen if there is a disaster or how will a new development plan impact traffic, makes it easier to understand and analyze the information and then communicate the results to stakeholders using these types of platforms.

Several leading-edge digital cities are beginning to take advantage of digital twin technologies. Singapore; Jaipur, India; and Rennes, France have already made investments to consolidate their data and bring their digital twin to life. These cities are using the platform for climate analysis and energy efficiency, traffic and public transit planning, permitting and zoning, and urban development.

Singapore currently uses digital twin technologies in its groundbreaking Virtual Singapore project (see Figure 1). Its power starts with the wealth of data that city planners bring into the system, such as terrain and water, infrastructure, transportation, and even vegetation information. Users of the system can then add additional data layers to the model with incredibly fine details about buildings not only with geometry and statistical characteristics but also with attributes such as building composition and materials. This detailed digital twin allows planners to run a simulation, see 5G coverage, create detailed plans for emergency evacuations and crowd control, and look at transportation flows across the entire city. Having this new level of sophisticated information will continue to unlock insights into the rapidly evolving urban landscape for years to come.

FIGURE 1

Screenshot of Virtual Singapore
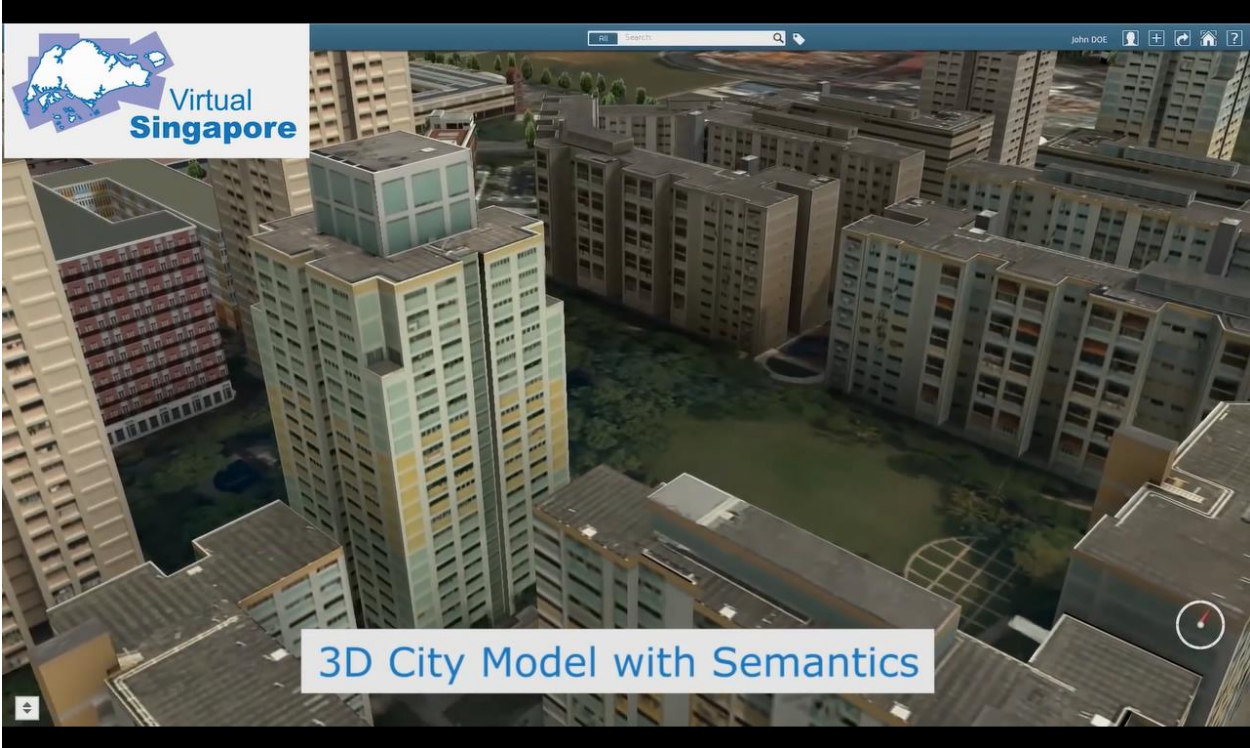
Source: https://www.nrf.gov.sg/programmes/virtual-singapore

FUTURE OUTLOOK

Cities will increasingly need methods to analyze, predict, plan for, and share insights and solutions to the most pressing problems. The world is already dependent on this depth of analysis and problem solving, and the gaps in these capabilities are sometimes crippling if a city hasn't positioned itself to address them. High-quality data is a big piece of the way forward but only if you have ways to break down barriers to sharing, collaboration, and consensus.

As artificial intelligence takes hold and IoT capabilities are increasingly deployed in cities, having a single version of the truth, and the ability to get it in front of people, will be the only way to truly take advantage of the full range of Smart City investments. Increasing integration across all of these domains will only add to the value of the digital twin as a key piece of the Smart City and technology portfolio. Your data ecosystem should always contain tools for collection, combination, analysis, and presentation of rich information.

Digital twin and other virtual and augmented reality technologies will represent the next generation of information interface over time. The ability of these technologies to provide an immersive experience in which to understand the world around us is perhaps unmatched at any time in history. The key will be making the platforms work for people and be actionable. As technologists and civic leaders think about what they need to make the hard decisions, having that mission-critical look into the "nervous system" of the city will need to be faster and more insightful than ever to be truly effective. With the power of these new platforms that are native digital applications, the fidelity available to users is unprecedented as the data generated by virtual simulations and deployed sensor technologies converge seamlessly.

CHALLENGES AND OPPORTUNITIES

Municipalities know that having accurate and timely data is an essential part of the decision-making process; the current issue is that there is too much data and not enough information. Being able to turn data into actionable knowledge is a challenge in even the most mature, data-driven organizations.

Roadblocks to Integrating Your Data

There are many struggles in doing work with data that are common to governments and agencies, both large and small, as well as private enterprises. Recognizing from the beginning where your challenges are will allow you to prioritize the work needed and follow a strategic road map to increase your data maturity.

- Current data assets are in silos. The barriers to combining data may be legal, organizational, or technical in nature. Creating the right process to share data is challenging but has immense potential to help your organization and constituents realize the true value of the data.
- You may not have detailed enough knowledge about what data you already have in your organization. Documentation can be scattered, outdated, or incomplete.
- Developers and other critical engineering resources might already be overextended.
- Coming to a single version of the truth requires some shared understanding of definitions and goals. The process of refining what this singular version of truth is can take time and will constantly evolve as new data is gathered and insights are generated.

Opportunities for Bigger Impact

For organizations, the upside of the challenges of working with data is that the foundational work required to get a return on the investment will also pay dividends across several lines of business and long into the digital future. Taking an evolving and incremental approach to build up your capacity and utilizing cutting-edge platforms will place the value of the data front and center.

- Better-quality, high-fidelity data leads to better-quality solutions to critical issues.
- Having the right collaborative tools will open up opportunities to engage stakeholders in a new and highly informative way, leading to higher-quality decision making. Working within the digital twin framework can present a new standard for getting community buy-in.
- Powerful visualization and analysis are often a gateway to a larger culture change, pushing people at all levels to adopt a more data-driven and information-rich approach to the work they care about.
- The added value proposition of tools such as digital twin technologies can be how they unlock data assets for a wide range of use cases.
- Consolidating data and analysis tools can lead to cost savings as employees spend less time on time-consuming maintenance and development, freeing up valuable resources for more innovative projects.

ESSENTIAL GUIDANCE

Determining where you go from here and how you get started not only is highly important but also likely has nuances unique to your organization. We recommend looking at your strategic road map for data, long-term urban planning goals, and expectations that decision makers and community members have for communication and collaboration.

Key Questions for Action

- Are your planning, emergency management, transportation, and public works agencies working together and sharing data as well as they could? Or are key issues and priorities not being solved because of the lack of ability to share data and have a common truth?
- Do you need the ability to play through "what if" scenarios and come up with ways to test contingency plans to mitigate risks and optimize planning?
- Are both your organization and your data ready to be integrated in this way? What people and tools do you need as part of this holistic ecosystem approach to take the next step?
- Do you need to increase stakeholder understanding of key issues by using information-rich tools?
- If you had a high-fidelity digital twin at your fingertips, where would you prioritize its impact?

Moving to a digital twin platform will become more commonplace in organizations as they move to mature, data-driven approaches. As virtual and augmented reality platforms increase their ability to provide higher levels of fidelity and power, there will be further opportunity to use them in more wide-ranging areas of land use governance and planning. By educating your stakeholders on the potential that these types of investments could have and defining key issues to solve, you will put yourself in a strong position to build toward a more information-rich and collaborative future.

Next Steps

IDC recommends the following steps to make sure you have clarity of vision and a concise business case to present to stakeholders:

- Have a clear use case in mind. Define the problem you're trying to solve that requires the level of detail digital twin technologies can provide.
- Know the data you have and the data you need. Is your data accessible and ready to be brought into a larger ecosystem? What barriers to this exist currently?
- Educate your constituents and stakeholders about what is possible using these tools; a demonstration of how 3D tools and augmented reality tools work is incredibly eye opening to first-time users.
- Define what success looks like for your organization. Is this the next step for your IoT and Smart City plan?
- Design your implementation road map to be additive, always evolving to bring more data to bear on a solution. Start small and constantly develop new functionality and insights, and new use cases will continue to emerge during this process.

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Global Headquarters

5 Speen Street
Framingham, MA 01701
USA
508.872.8200
Twitter: @IDC
idc-community.com
www.idc.com