City Digital Twins: the future of urban management

— by Raül Daussà & Balbina Rocosa

At a time when tech maturity is breaking barriers, City Digital Twins are proving to be a real game-changer for simulating and testing new policy scenarios for cities.

In the rapidly evolving landscape of urban management, **City Digital Twins (CDTs) are emerging as a transformative technology**. But what exactly is a CDT, and why is it generating so much interest?

What is a City Digital Twin?

A City Digital Twin is a digital replica of a city that integrates real-time data from various sources and fields into a comprehensive 3D model. This digital representation **allows urban planners and decision-makers to simulate and analyze the effects of different actions** on the city's infrastructure and environment. Essentially, a CDT provides a living virtual model of a city, continuously updated with data from IoT devices, sensors, and other digital inputs to evaluate and simulate various scenarios within context.

Currently, CDTs are experiencing a boom, and this is no coincidence. The maturity of technologies such as IoT, cloud computing, and artificial intelligence now allows for the **collection, processing, and analysis of massive amounts of real-time data** and the modeling of different possible scenarios. Additionally, the Covid-19 pandemic highlighted the need to be prepared to manage unforeseen crises comprehensively, **positioning CDTs as an innovative solution for urban response to these disruptions.** Finally, initiatives such as the European Digital Infrastructure Consortium (EDIC) provide a regulatory and financial framework that facilitates the implementation of large-scale CDT projects in Europe, promoting collaboration among cities around this solution.

The multifaceted utility of City Digital Twins

CDTs serve multiple purposes in various urban domains:

- **Improvement of Urban Understanding:** By visualizing data on transport, energy consumption, water use, and waste management, along with other city aspects, CDTs provide a holistic view of urban systems. This comprehensive vision helps different city stakeholders understand complex urban dynamics.

- **Simulation and Planning:** One of the most powerful features of CDTs is their ability to simulate different scenarios. For example, urban planners can predict the impact of new infrastructure projects or policy changes. This capability allows for anticipating and improving public services.

- **Efficiency:** CDTs can support informed decision-making and administrative processes, making cities more agile and responsive.

Real applications: from traffic management to wnvironmental sustainability

CDTs are being used to tackle specific urban challenges through innovative applications:

- **Event Management:** Large-scale events like sports games or concerts can be difficult to manage. CDTs can simulate the impact of these events on traffic, public transport, and public safety, allowing for better preparation and response.

- **Sustainable Mobility:** Cities like New York and Phoenix are using CDTs to improve traffic management and reduce carbon emissions. By analyzing real-time data, these cities can optimize traffic flows, reduce congestion, and minimize environmental impact.

- **Public Space Optimization:** In cities like Helsinki, CDTs are used to plan and test urban initiatives digitally before implementation. This approach has proven effective in improving urban spaces and ensuring public investments yield the best possible results.

Who's leading the race? Notable initiatives globally

Various cities around the world are leading the way in CDT implementation:

- **Barcelona and its Digital Twin:** Barcelona, strategically advised by Anteverti in terms of digital infrastructure, is also committed to implementing its Digital Twin, with a primary goal of decarbonization. It already has experience in integrating real-time data infrastructure from various sources including sensors and different urban management systems. Currently, it is participating in European projects, such as VCity with the Barcelona Supercomputing Center and EDIC, which will advance new use cases and exchange experiences among cities to consolidate valuable knowledge and necessary infrastructure.
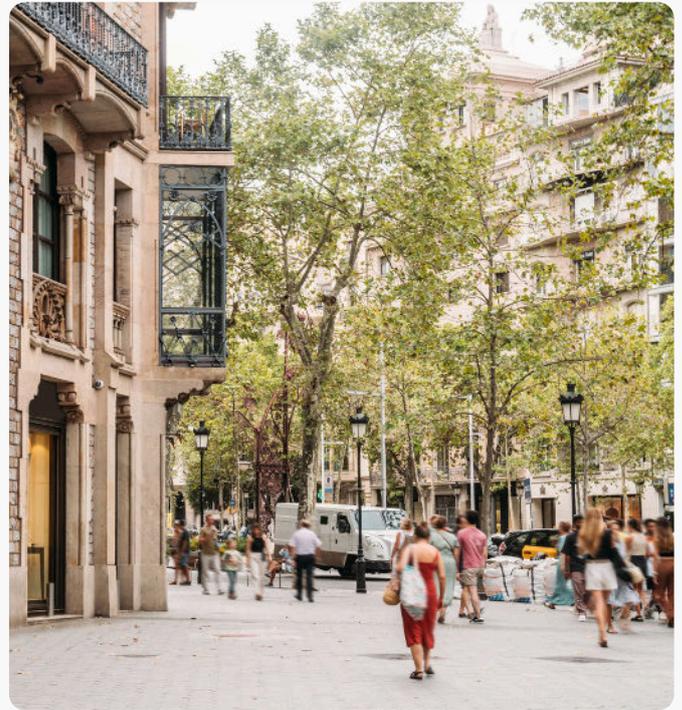
- **New York City, United States:** Known for its innovative use of digital twins to manage traffic and improve safety, New York City's project demonstrates the practical benefits of this technology in large metropolitan areas.

- **Singapore:** this nation-city has deployed Virtual Singapore: a comprehensive city digital twin that integrates 3D models with real-time data to support urban planning and disaster management.

- **Phoenix, United States:** Arizona's capital uses a digital twin to help reduce CO_2 emissions and improve traffic management in its metropolitan area. This project is part of a broader initiative to make American cities more sustainable and efficient.

- **Seoul, South Korea:** A Digital Twin Platform monitors urban infrastructure and provides real-time data to optimize city management. Future plans include expanding this platform to a 4D model, incorporating time as an additional dimension.

- **Las Vegas, United States:** Nevada's largest city has implemented a digital twin to monitor and manage CO_2 emissions and improve traffic efficiency. This project is part of the "Clean Cities – Clean Future" initiative by Cityzenith, which aims to reduce emissions and improve urban sustainability through digital twin technology.

- **Helsinki, Finland:** This Nordic capital has two digital twins: one for the city in general and another for the Kalasatama district. These models allow for planning and testing initiatives digitally before actual implementation, enhancing the precision and efficiency of urban policies.

- **Chattanooga, United States:** Uses a digital twin to model and alleviate traffic congestion. Traffic congestion experiments conducted in this virtual environment have shown up to a 30% improvement in traffic flow, resulting in greater energy efficiency.

In conclusion: who wouldn't want to predict the urban future?

There is no doubt: **City Digital Twins are an indispensable tool for modern urban management, aimed at addressing transversal challenges** and offering the possibility of a data-driven governance model. At this moment, when we have the necessary technology to **integrate real-time data and simulate scenarios,** CDTs enable us to predict how to improve the planning, efficiency, and resilience of urban services. Their adoption by leading cities worldwide underscores a clear message: they are a transformative tool for urban prosperity, sustainability, and resilience, ultimately allowing us to face future challenges with greater certainty and guarantees of success.

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