Invesco

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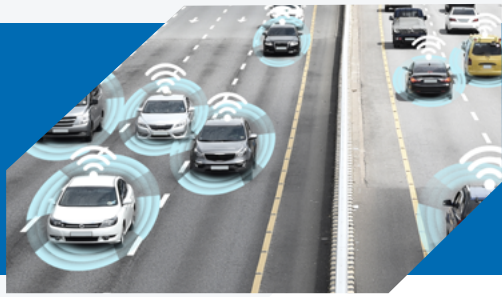
THE END OF TRAFFIC JAMS?

Smart-city transport solutions—from intelligent toll roads to scooter-sharing systems—are making cities more efficient and breathable.



- **Smart technology is making city transport faster, cleaner and more efficient**
- **Intelligent transport is creating a wide variety of investment opportunities**
- **Autonomous vehicles are here—but widespread adoption will take time**

Traffic jams are not only annoying—they are also expensive. According to INRIX, a Kirkland, Washington-based data company that monitors traffic congestion in big cities across the world, in 2017 delays cost Los Angeles US$19bn and New York US$35bn in lost productivity and extra fuel costs.[1] No wonder, then, that clogged roads are among the first targets of municipalities aiming to become smart cities.

"Population centres are densifying," says Abhi Gami, senior investment analyst at Invesco, who covers the emerging technologies that enable smart cities. "There's a realisation from cities that they are not going to be able to adequately support these denser communities without some sort of automation or more intelligent or more strategic management of the city. You can have a population centre with lots of talent, but if they can't get to and from work, the productivity of that talent will not achieve its potential."

A SMART BLEND OF HARDWARE AND SOFTWARE

Smart cities bring together two of the most important technological innovations of the past ten years: the Internet of Things (IoT—low-energy devices such as sensors and actuators that are connected to the cloud), and artificial intelligence (AI) algorithms that are able to crunch the data these devices generate. Combined, the two turn a city into a technology-based ecosystem that is able to monitor (and often has a significant influence on) factors such energy use, crime levels, air quality, and of course traffic.

"A smart city," says Mike Zeto, vice president, IoT at AT&T, who is spearheading the company's involvement in the sector, "is a city that uses IoT technology strategically to drive operating efficiencies and create a safer and a more liveable, sustainable and equitable environment for all of its citizens."

TO GET AHEAD, GO SLOWLY...AND GET HELP

Right now, many of the world's smart-city projects are relatively small pilot schemes, with planners mindful of the urban design mistakes of the 20th century, not least the congested roads that smart-city technology is trying to rectify.

"We are so early in some of the planning stages," says Mr Gami, "that bad decisions today could lead to suboptimal solutions. So what we are seeing is more incremental change, cities spending US$10m, US$20m, US$30m, starting with a pilot and then building slowly from there."

One such example is Barcelona, the second most populous city in Spain, which leveraged about 500 km of fibre-optic cable to connect its bus stops to the internet, turning them into WiFi access points. These, in turn, connect with WiFi-enabled street lamps that monitor traffic flow and air quality, and with parking meters that identify the presence of parked cars. These data are made available to an app, which motorists can use to identify free spaces and which then charges their credit card automatically as they park.

"They are using the WiFi network to help reduce traffic congestion," says Clay Manley, a portfolio manager and Mr Gami's colleague at Invesco's Houston, Texas office, "and they are seeing improved quality of life for their citizens. And in the case of the parking meters, driving higher revenues—[they have seen] an estimated US$50m increase in parking fees."

Barcelona's smart move, says Mr Gami, was to make the upgrade of fibre-optic cabling part of its general maintenance programme, saving significant costs.

"They did not have to restructure the city or create a new city," he says. "The 500 km of fibre were laid ahead of the 1992 Olympics and then expanded as they were doing traditional public-works projects, digging up streets and laying new streets."

But the digital infrastructure which these cables have enabled has created a new asset for the city: the data generated by all those sensors.

"One of the things they have done," says Mr Gami, "is to make a very open platform to share that data with their citizens and other technology and city developers, allowing innovation to come from the market. They want third parties to come in and utilise the infrastructure they have built and make it bigger and better."

CLEARER STREETS, CLEANER AIR

Traffic management is not only about congestion, it is also about pollution, and many cities see electric vehicles and multimodal transport—whereby goods or people use more than one means to get to their destination—as potential routes to address both of these issues. Columbus, Ohio, for example, is piloting a "connected traffic system", including smart street lamps, the rollout of 100 electric vehicles, e-bikes for police officers and the installation of charging points in multi-unit dwellings.

However, Stephen Anness, an Invesco portfolio manager based in Henley-on-Thames in the UK, warns against putting too much hope in electric vehicles at this stage.

"There are quite significant challenges to overcome first," he says, listing a global shortage of cobalt, a key mineral used in the manufacture of batteries, the current high price of electric vehicles and their relatively short driving range, as well as the potential inability of city grids in their current form to supply the power needed for charging large numbers of electric cars simultaneously. Even just solving that last problem will be a challenge, he says: "To generate the sort of power required and to place all the cabling in the ground, I think will take decades."

THE END OF CAR OWNERSHIP

In the meantime, many cities are instead encouraging their citizens to swap their private cars for membership of a car-sharing scheme. According to Robin Chase, a transport consultant and founder and former CEO of Zipcar, an American car-sharing company, programmes such as these will be key to making transport smarter.[2]

"Technology has made sharing easy and frictionless," she says. "It allows vehicles to be used intensively, with algorithms linking people and vehicles."

And the impetus for change, she says, is coming from city dwellers themselves. (Bird, an electric scooter-sharing company, for example, recently became the fastest start-up ever to reach a US$1bn valuation).[3]

"We are seeing more shared bike use," she says, "more e-bikes, more electric scooters, more microtransit [minibuses with flexible routes], more restricted parking [for non-shared vehicles], experiments with curb pick-up and drop-off and with dedicated lanes. And all of this is establishing new behaviours."

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GOODBYE, DRIVER

At some point in the smart-city future these vehicles will also be autonomous, continually cruising the streets during the day, using city data to select the best route to find people waiting for a ride and recharging themselves in out-of-town car parks overnight. Autonomous vehicles will have as big a transformative effect on city life as the invention of the car itself, and manufacturing, maintaining and managing them is likely to create significant investment opportunities. (The global market for autonomous vehicles is expected to reach the trillion US dollar mark by 2025.) [4]

As to when all traffic will be autonomous, few people will hazard a guess. The sector faces large technological, social and regulatory challenges. While the shift to autonomous vehicles will first happen with respect to highway driving, which is far less complex than city driving, no one doubts that many cities are heading in that direction. And as Mr Gami points out, the significant investments that are now being made in smart-city transport are bringing that vision ever closer to reality.

[1] Source: *The Economist*, "People say they hate traffic jams but are oddly tolerant of them" September 6th 2018. https://www.economist.com/international/2018/09/08/people-say-they-hate-traffic-jams-but-are-oddly-tolerant-of-them

[2] This document is thought leadership content and is not intended as a recommendation to invest in any par-ticular asset class, security or strategy. Regulatory requirements that require impartiality of invest-ment/investment strategy recommendations are therefore not applicable nor are any prohibitions to trade be-fore publication. The information provided is for illustrative purposes only, it should not be relied upon as rec-ommendations to buy or sell securities.

[3] Source: Quartz, "Bird is the fastest startup ever to reach a $1 billion valuation" June 14, 2018. https://qz.com/1305719/electric-scooter-company-bird-is-the-fastest-startup-ever-to-become-a-unicorn/

[4] Source, Risk & Reward (Invesco), "Driverless cars: How innovation paves the road for investment opportuni-ty" Issue #2, 2017

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PREDICTING URBAN EVOLUTION

Institutional real-estate investors are mining smart-city data to understand the opportunities created by new patterns of movement, improved energy efficiency and future climate change.

- **Smart buildings will be key to tackling global warming**
- **Data are reshaping the real-estate investment industry**
- **Today's most advanced smart cities started modestly, adding new capabilities gradually rather than trying to build from the ground up**

"Investing in real estate," says Tim Bellman, head of global research at Invesco Real Estate, "used to be a really simple thing. You looked at supply and demand."

Now it's much more sophisticated, he adds. Data-driven buildings allow investors to make better informed decisions and monitor their properties more closely, as well as potentially creating new data-related revenue streams.

On top of that, highly efficient buildings not only reduce expenses but also help to address environmental challenges, an important consideration for investors guided by environmental, social and governance (ESG) issues such as climate change and human rights.

SMART AND SUSTAINABLE

According to Mr Bellman, the green shoots of smart-city real estate are already visible. "If you just look at the number of people walking around cities with smartphones, those effectively smart individuals are interacting with smart buildings," he says, connecting with those buildings' WiFi networks or having their presence detected by sensors in a building's walls and floors. And once they are in, buildings can use those data to adjust services, such as heating and air conditioning.

"When you walk into a building," he explains, "your movements are measured, and in some of our buildings systems measure the number of people coming in and out and automatically adjust and regulate temperatures."

This, of course, lowers costs by improving energy consumption. Cities are triumphs of real estate—the most efficient use of land on the planet—but large buildings are big consumers of power, needed primarily to light, heat and cool large internal areas that are disconnected from the outside world. Making them more energy-efficient, says Darin Turner, managing director and portfolio manager for Invesco Real Estate and Mr Bellman's colleague in Dallas, Texas, is a key part of smart-city planning.

As an example he points to Prisma Tower, an Invesco-backed development in the La Défense business district of Paris, where heating, cooling and telecommunications are provided by an external facility shared with a number of buildings.

"That's a type of approach that has been around for generations," he says, "but its use of modern technology makes it unusual. The building doesn't have to utilise space for those purposes. We buy in those services at a cost-effective rate, and that means the building is more efficient."

It is also what makes real estate more sustainable in the long term.

"When you are trying to understand sustainability, you have to have some key design principles," notes Mr Turner, "things like resilience, flexibility and safety. But the other element is the impact of climate change—understanding how you need to be thinking about not just expectations for today but expectations 15-25 years from now."

INVESTING IS CHANGING, TOO

These principles are already influencing how institutional investors assess real-estate opportunities.

"Over the last decade or so," says Mr Bellman, "environmental and social-governance principles have become a very important part of investing generally, and we have found that doing the right thing for the environment was also a smart commercial decision. It made our buildings more attractive to tenants and it cost us less to run them."

City "smartness" has also, he adds, increased the complexity of real-estate investing, turning it into a much more finely tuned data-driven search for higher potential returns.

"At a very high level, a real-estate investment strategy relies on two things: signs of growth or change," he says, "and smart cities are leading to changes in the patterns of movement within cities and the intensity of use of individual buildings. So this is an exciting area for us to try to identify new patterns of value that will show outperformance in the varied buildings we can invest in."

Those patterns, he explains, can be found in the huge amount of data that smart cities now generate. "It's much more fine-grained. We can go down to street blocks and corners. We can come down to the

number of restaurant bookings in an area or the number of people who have been observed parking in a particular location. And we can use data mining to try to understand where value is being created."

A KEY ROLE FOR CITY HALL

Good-quality data depend on the presence of sensors—although, as Mr Bellman points out, smartphones are already generating a large amount of that information, and while individual smart buildings can play their part, much depends on the commitment of the city as a whole to building a digital infrastructure.

"The key to being able to make this transition to a smart city is having that ability for overall connectedness," says Mr Turner, "mostly driven by your overall internet capability, but then also by your devices around that internet capability. So areas that we have seen that are the most advanced [in becoming smart cities]—places like Amsterdam, New York, Seoul, Singapore—very much have that initial layer of telecommunications infrastructure in place. It's mostly places in Africa, India, Latin America that are very far behind in installing that base layer of sensors that are really needed to make a smart-city environment."

However, he says, that lack of infrastructure could be to the advantage of developing countries. "In the developed world, you are not only trying to plan for the future but also attacking what's currently on the ground. You have to incorporate planning around what is existing, and that can slow you down."

By contrast, developing countries get to build from scratch. "They have the ability to really leap forward on technology," he says

A GLOBAL PHENOMENON

That opportunity has not gone unnoticed, particularly by China, which is investing heavily in smart-city developments, including significant commercial and residential real-estate projects both within its borders and across its Belt and Road Initiative. [1]

Internally, China has partnered with four of its biggest technology companies—Ping An, Alibaba, Tencent and Huawei—to create what it calls the PATH to Smart Cities initiative (the name is an acronym of the companies' initial letters), developing smart-city capabilities in 500 cities across the country. And it is involved in a number of overseas smart-city projects, including a partnership with the Philippines government to build from scratch a 407-hectare smart city, the City of Pearl, on reclaimed land in Manila Bay.

Other countries, including India, the United Arab Emirates and Saudi Arabia, are following China's lead and are unveiling strategies to drive smart-city development. India is planning to upgrade 99 of its cities from 2022 onwards under the country's Smart Cities Mission, and Saudi Arabia has plans for a brand new smart city, Neom, which will cover 26,000 sq km of what is currently desert land.

TURNING SMART DREAMS INTO SMARTER REALITY

Developments such as these are not short of ambition, but Abhi Gami, senior investment analyst at Invesco, advises caution.

"The huge projects that people have been dreaming up for years have mostly fizzled out because they require people to accommodate technology," he says, "instead of technology organically accommodating how people live."

He cites as an example Songdo in South Korea, a smart city which has been built from scratch and has many smart-city innovations, including a central pneumatic waste-disposal system, but which has failed to attract residents. It is currently home to about 70,000 people, far short of the 300,000 it has been designed to accommodate.

PREDICTING URBAN EVOLUTION

Institutional real-estate investors are mining smart-city data to understand the opportunities created by new patterns of movement, improved energy efficiency and future climate change.

"The cities that are most advanced share the fact that they started modestly and slowly added new capabilities", notes Mr Gami.

Early phases of the City of Pearl are expected to open in 2024, but according to Nicholas Ho of Hong Kong-based Ho & Partners Architects, the project's lead designers, the development will probably take "two decades" to complete.

By then we will need many more smart cities to house and service the world's growing population, nearly 70% of whom will be living in cities by 2050, according to UN estimates. And that is exciting the conventional world of real-estate investment.

"We are talking about investing in areas that are new," says Mr Turner. "Just from understanding the potential impact [of smart cities] and what that means for our quality of life, it's an exciting time to be a real-estate investor."

Mr Bellman agrees.

"That interconnection of smart buildings with smart cities," he notes, "creates the potential for us to generate additional value from our investments."

[1]Belt and Road refers to a large-scale infrastructure and investment initiative by the Chinese government focused on countries in Europe, Asia and Africa. "Belt" is a reference to overland routes and "road" refers to the sea routes.

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INTELLIGENT INFRASTRUCTURE

The smart city of the future will leverage technology to improve the overall quality of life for citizens, including their safety, health and more. Doing so could also create attractive new investment opportunities.

- **Cities will have to become smarter to attract and retain citizens**
- **Smart-city technology and the data it generates are creating entirely new asset classes**
- **A new type of contractor is emerging to facilitate the innovations cities need**

It's no surprise that many of the world's successful smart-city projects have focused their efforts on transport and real estate. Free-flowing streets and buildings that are comfortable to live and work in are sure ways to earn the support of city dwellers. But the real heart of a city lies both literally and metaphorically below its surface, in the infrastructure that delivers energy, safety, reliability and sustainability to its citizens.

While less visible than intelligent traffic lights or city-wide WiFi, these systems provide the backbone for the day-to-day features that future urban dwellers will come to rely on. And according to Clay Manley, portfolio manager at Invesco, they could also create significant new opportunities for investors.

"Technology investors focus on the picks and shovels and solutions that will be effectively creating these smart cities," he says.

"SMARTNESS" IS NO LONGER A CHOICE

In many cities, becoming smart has until now been viewed as a desirable option rather than a necessity, one to get round to once the more prosaic aspects of city management have been addressed. But, says Steve Hong, senior research analyst at Invesco, that is no longer the case. Cities will need to become smart to survive.

"Millennials, especially, are very tech-oriented," he says, "so to attract them to your city you need to be connected, you need to be up-to-date with technology and related infrastructure."

And Mark Gilley, Invesco's head of municipal credit research, adds that skimping on smart-city investment could, in the long term, damage a city's ability to raise capital as companies and individuals abandon it for smarter rivals elsewhere.

"More people then move to smart cities because they are a more pleasant place to live," he says, "so you have population growth versus population decline, which can reduce the tax base and lead to credit problems."

MORE THAN JUST CABLES AND SENSORS

Michael Zeto, vice president, Internet of Things (IoT) at AT&T, which is working with a number of US cities to develop smart-city programmes, agrees. For him, a smart city is about providing a "sustainable and equitable environment for all its citizens", which includes addressing broader challenges, such as crime and inequality.

In Atlanta, for example, LED street lamps are being fitted not only with sensors that monitor air quality but also with microphones that are able to detect unreported gunshots and automatically alert the emergency services. And in Miami-Dade County, AT&T is part of a partnership installing closed-circuit television security cameras in public-housing complexes that double as WiFi access points, bringing high-speed internet connectivity to areas of the city that have until now been underserved.

As Mr Manley points out, this in turn raises wider concerns beyond simple technological innovation.

"None of this is going to happen," he says, "without solving issues around, for example, security and privacy."

A NEW TYPE OF CONTRACTOR

The complexity of smart-city projects, which often involve multiple suppliers working together over a long period of time, has led to the emergence of a new type of company that is, in effect, offering a whole smart-city package—from financing through to construction, delivery and beyond.

One of these is Fort Lauderdale-based Smart City Capital, an end-to-end smart-city solution provider delivering a combined matched funding, advisory, project management and technology platform, which is involved in a number of smart-city programmes in the US and overseas. According to Oscar Bode, Smart City Capital's founder and CEO, cities have three challenges when they set out to become smarter.

"The first problem is know-how. A lot of cities around the world, whether it's Paris or Philadelphia, know they need to be smart to attract and retain industry and have their economic development take place," he says. "But they don't know how to get there."

Then, he adds, there is the challenge of understanding and harnessing new income streams that smart cities are creating.

"You have new asset classes that are being developed, such as big data analytics, fleet-management savings, efficiency in trash-collection routes," Mr Bode explains. Cities can, for example, offer investors the option of a value exchange. This might involve financing the set-up costs for a city's smart transport network in exchange for exclusive rights to the premium data that the network generates.

And finally, there is the complexity that smart-city projects inevitably entail.

"There's no longer a single provider," he says. "You could have multiple application companies, hardware companies and construction companies, and they all need to work together."

DATA ARE THE NEW OIL

A big attraction of smart-city projects for investors, according to Mr Bode, is the value of the data they will produce. And big cities won't be the only ones to profit. Smaller cities will likely also be able to compete with their larger neighbours.

"A small city could have 150,000 trucks driving through it every month, and that's going to generate data. So that city, which was ignored in the past, should also be able to benefit from investments by pooling its data with that of other, smaller cities."

The fact that funding can be raised on the basis of the long-term value of something as intangible as data is an indication of how new the smart-city sector is. But according to AT&T's Mr Zeto, we are now moving from a phase in which most of the initiative has been taken by city halls to one where citizens will be more actively engaged in the project of making cities better places to live. (For example, through citizens providing data that improve city life, such as updating traffic information through navigation app Waze to make commuting smoother.) And then, further in the future, "maybe 2025 and beyond", in Mr Zeto's estimation, we will attain "a utopia of technology being applied strategically to solve a lot of different problems at one time using the data from all these IoT-connected sensors."

But even then, says Tim Bellman, head of global research at Invesco Real Estate, smart cities will still continue to develop.

"The technologies will evolve and change," he says. "The data analytics, which are key underpinnings for smart cities, the management of information, the resources—those things are all going to go through cycles and revolutions. For me, 'smart cities' is an umbrella term, a general direction of travel: the use of technologies, policies and data to improve the lives of citizens. I don't think there's going to be a point at which you declare a smart city finished."

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