Atos Cognitive Data Platform

Unleashing the power of data to improve quality of life

Expert Paper 2021

Atos

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For cities and local authorities, the urgent need to meet key sustainability goals and deliver smart services demands more unified thinking and integrated delivery. To inform decision-making on aspects such as mobility, public safety and waste management, smart cities must employ vast lakes of data from growing numbers of applications, sensors and edge devices via the Internet of Things (IoT).

In the past decade, Atos has worked to create the best platform for smart cities, based on open source and open standards, to support city initiatives on a global scale. Where most cities started with a "vertical" approach, focusing on a single topic such as lighting or parking, we focused on the "horizontal" layer, to maximize the benefits of combining data from many different sources, avoiding silos within the city and fostering the Data Spaces concept. Today, we see our efforts pay-off: instead of just smart cities, we can now apply this approach to the campus, grid, airport, seaport, territory or agriculture. **The power of data can be released using a single platform, creating a new data economy**.

The Cognitive Data Platform is Atos's open, interoperable and standard solution for smart services, applicable in any vertical domain (including smart cities, smart agriculture, smart campus and smart infrastructure). It enables the collection and integration of information from sensors and other data sources, normalizing that data and processing it to provide aggregated and intelligent views of raw data to support decision making. The platform uses open source software and open standards for maximum interoperability, and provides a set of functional blocks to build smart solutions from context information, making it modular and flexible to deploy.

Delivering digital transformation and building a new data economy is where the strength of Atos is most evident. From cybersecurity to high performance computing, from edge computing to secure networking, our full portfolio of services and products supports it all.

This paper brings together ideas and experience from experts across Atos and some of our partners — to help authorities address their challenges through collaboration on new data solutions.

An industry approach to smart services

Christoph Beger
Atos Head of Public Community Services & Education

Decarbonization is a leading topic for Atos. To enable and accelerate the changes needed to lower the world's carbon footprint, data is one of the most powerful weapons we have, enabling us all to make better-informed decisions. Choices in our daily lives, such as whether we need to travel and what is the best transport mode and itinerary; but also, insights into our consumption patterns and the impact of what we buy, where and when.

Atos already supports decarbonization across the value chain: from resource management to production, logistics and retail. In the end, it is we as individuals — the consumers — who need more information to help reduce carbon emissions. Joining data in a smart way makes it possible to generate information where, when and how it is needed.

Changing behaviors

Cities must take the lead in making the energy transition work at a local level. The Cognitive Data Platform enables a city to support the local energy exchange between citizens to promote further extension of privately owned photovoltaic (PV) systems, including collectives deploying PV systems on rooftops of public buildings. If the surplus of energy can be distributed across participating citizens, interest to invest in private PV systems will increase.

Mobility-as-a-Service is not just a different way to travel, it enables authorities to promote decarbonized transport. The Cognitive Data Platform, by connecting various transport options, provides a single view across different operators, encouraging and promoting a trans-modal shift. Ease of access through a uniform payment system will accelerate the shift. If cities want to actively promote and manage this, a city card can be added to the public platform, supporting access not only to transport, but to a range of different services.

A smart approach to become data-driven comes at a cost to start with; cities must make an investment to kick off the digital transformation. The question for local authorities and stakeholders, however, should be "*What outcomes can we expect, and how can we maximize economic opportunity from the start?*"

2 Introducing the Atos Cognitive Data Platform

To become a smart city, authorities often start with small projects on vertical (siloed) solutions. There are many examples and most start with "smart" — smart parking for example. However, as the former Chief Technical Officer of Q-park once said in a conversation with the Chief Information Officer of a large city, "*There is nothing smart about parking. Either you can park or you can't. It is the information you can receive up-front — to know whether there is availability or not and change plans — that makes it smart.*"

This message basically explains what "smart" is for cities. It is about creating valuable information that people can access when, where and how they decide. However, this is only realizable if the city can collect, manage and publish the data to create information services — personalized if possible. Therefore, the strapline for our smart city vision is, "*A smart city is a data-driven city*." This applies to city operations, city services and to new opportunities for a data economy.

Single pane of glass

To make smart cities a reality requires a single Cognitive Data Platform to manage all the data. This platform is the centerpiece of a "system-of-systems" or "platform-of-platforms" approach. The data-driven approach depends in large part on the trust and confidence the city can ensure in the reliability of the information provided, underpinned by data accuracy, availability and accessibility.

So, why a platform-of-platforms approach? Because, for example, not all streetlights will come from a single vendor, and each vendor has its own control/management platform. Collecting data from all connected platforms is key to creating a "single pane of glass" for lighting, energy consumption, worn-out lightbulbs and so on. It also enables use of city data and external data, such as the weather and crowded areas, to control the lighting settings from the Cognitive Data Platform as the central system. Of course, there are many more examples.

Definition

The **Atos Cognitive Data Platform** enables a city to capture, manage and publish data across
the city's operational areas, providing a single access point for data-driven services for known and unknown users.

Market: Size, Demand and Offering

Introducing the Atos Cognitive Data Platform

Source: STATISTA 2020

Topics that the platform can help authorities address include:

► Citizen services
► Mobility
► Safety
► Economy
► Sustainability
► Care
► Governance

Key features

The key features of the Atos Cognitive Data Platform are:

► Device management for all data points in a city
► Data security, as in cybersecurity and edge computing
► Secure connectivity as in cybersecurity
► IoT data collection management

Introducing the Atos Cognitive Data Platform

► Data infrastructure security — such as two-factor authentication in Horus, Evidian and Bullion
► Data provisioning to support multiple use cases — as in Data Lake as a Service
► Artificial intelligence (AI) operations whether local or external AI routines are used
► Data access security for known users — such as Azure Directory
► Data access security for unknown users through apps — like IDnomics certification

For cities, it is important to create an ecosystem of partners to create services and use data. It is also important that the Cognitive Data Platform adheres to open standards and is based on open source technologies. Any risk of vendor lock-in will prohibit cities from creating their own data economies.

3 Atos Cognitive Data Platform: secure, open and flexible

Sylvie Le Guyader-Colliot
*Atos Director Digital Platforms Public Sector & Defense Industry*

Local authorities want to offer citizens a good place to live and provide a good infrastructure for businesses to drive economic development. Exploiting all the data generated by a wide ecosystem of applications and devices is key for these authorities to take appropriate decisions on investments and fulfill their public service mission. This means that cities, territories and regions need to be connected in order to collect, merge and exploit data from various sources.

Advanced hyper-connected technologies such as the Internet of Things (IoT) and artificial intelligence (AI) are now mature enough to enable administrations and community ecosystems to:

► Break silos to improve efficiency in decision making and optimize investments
► Support sustainability and green growth
► Improve local services — faster and better
► Provide better quality of life
► Leverage collective intelligence of the local ecosystem (citizens, enterprises, local authorities) through networking and connectivity

Atos provides a sovereign cloud platform called the **Cognitive Data Platform**, which enables any organization to collect all data and provide appropriate monitoring dashboards.

It integrates **a horizontal interoperable layer** (a standardized IoT framework) to ingest, analyze and present a collection of data. This means it can easily integrate any existing system and supports monitoring of embedded systems.
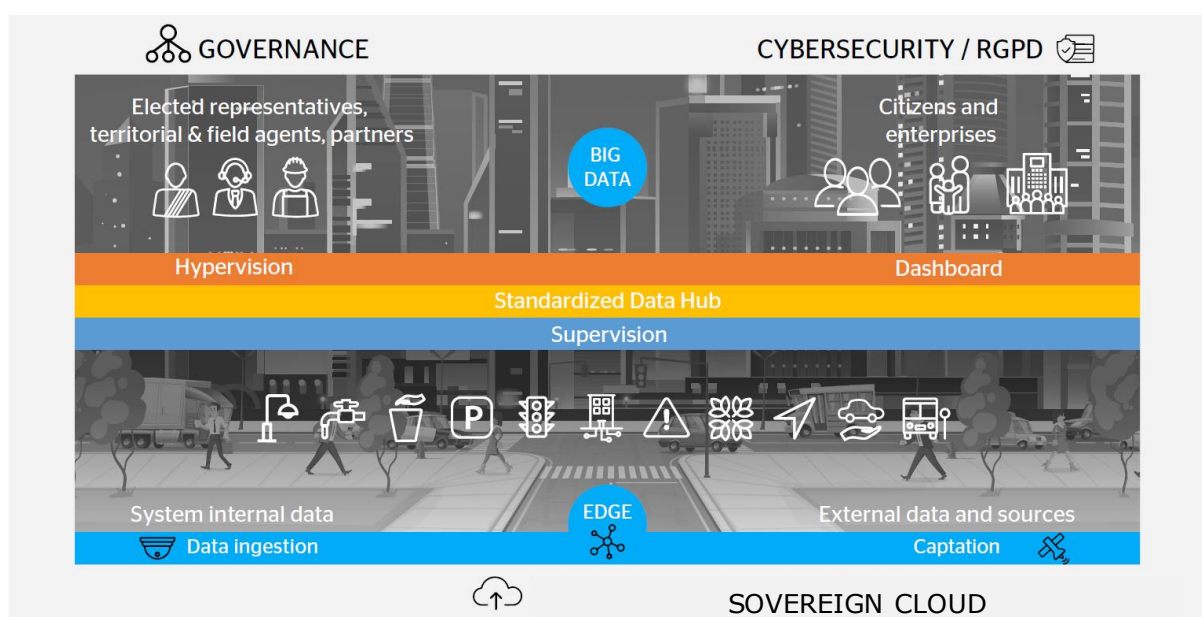
Atos Cognitive Data Platform: secure, open and flexible

Flexible, scalable and interoperable

Based on hybrid cloud **containerization**, the platform is highly scalable and stores historical data and indicators which are correlated and analyzed using AI. It embeds an edge system to improve latency and delivery of services. It comprises functional blocks called generic enablers to build smart solutions from context data.

The Cognitive Data Platform is **based on the FIWARE open standards**. The FIWARE Foundation is a non-profit organization that drives the definition and encourages the adoption of open standards (implemented using open source technologies) that ease the development of smart solutions across domains such as smart cities and smart energy grids. Atos is a founding member of the FIWARE Foundation.

The Atos Cognitive Data Platform integrates open standards that are publicly available and non-proprietary. The following main standards have been implemented on our platform:

FIWARE	Provides open standard APIs, Next Generation Service Interface (NGSI), to facilitate the consumption of IoT data and the processing of contextualized data in real time on a large scale.
oneM2M	Interoperability standardization for IoT platforms, providing common services functions that enable applications in multiple domains, using a common framework and uniform APIs.
LwM2M	A device management and secure enrollment solution, with guaranteed interoperability between the devices and the platform.
ETSI ITS	Communication standard for intelligent transport systems, enabling management of communications between vehicles and with the infrastructure.

Multiple use cases and a rich partner ecosystem

The platform is highly secure, with cybersecurity products and services from Atos that protect user data. It is user-oriented and focuses on creation of value for users. It is an extensible and flexible platform that accelerates innovation and breaks down barriers between organizations.

The Atos Cognitive Data Platform supports many uses cases, such as mobility-as-a-service, air quality improvement, energy management, environmental protection and food management.

New use cases are added frequently, thanks to a growing ecosystem of start-ups, local partners, utilities companies and software publishers — all bringing state-of-the-art expertise and innovations to connected territories and communities.

As a leading systems integrator and supplier of hosting services and digital innovation tools, Atos supports local authorities at every stage to successfully deliver use cases supported by the Atos Cognitive Data Platform.

If you would like to learn more, see a demo or have a discussion about implementing the platform and developing use cases, we can organize a workshop or a proof of concept to define your objectives and project.

4 Sustainability

4.1 Sustainability the smart way

Albert Seubers
Atos Director, Global Strategy Smart X

The cleanliness of our streets is central to our day-to-day experience in cities — and an important factor in attracting visitors and maintaining a positive image. So, what makes a city clean? Creating and maintaining clean spaces requires a partnership between city services and citizens; and sharing data within communities can make this partnership more effective.

Informed choices

Today's clean cities promote a healthy environment with good air quality and no litter. Air quality is highly impacted by traffic and, in some cases, by household heating systems.

With the right information at our fingertips, we can participate in looking after that environment by adjusting our daily routines — for example, by using data to make more informed decisions about how and when we travel, or about how we can save on energy to lower our city's carbon footprint.

Transitioning energy

Energy transition is one important element in creating a cleaner and healthier city. This means reducing levels of pollution from carbon-based energy sources and changing to renewable sources where possible. Energy transition requires not only available and accessible new energy sources, but also a change in the mindset of citizens to use alternative energy sources and reduce energy use. Communities of citizens already exist in many cities to invest in renewable energy systems and to buy energy collectively. In parallel, smart meters that provide real-time feedback on energy consumption help citizens to understand the impacts of their consumption.

Increasing sustainability

The City of Grenoble launched a large-scale smart grid between the historic city and the science campus to develop sustainable living solutions. Initially, 500 next-generation smart meters were installed to provide information to raise awareness and inform the public. By making this information accessible while respecting the privacy of individuals and protecting their data, the project will enable everyone in the city to become more involved and aware.

With air quality already under threat in some places, travel needs to be reduced (especially at peak times) along with switching to more sustainable forms of mobility. Many cities are making the switch to electric or hybrid vehicles, and public transport is also becoming greener.

Holistic approaches

Data is a powerful weapon against the more visible pollution caused by litter. Sensors that indicate a bin is full create data that enables waste collection services to optimize routes and reduce mileage. However, these services need a contractual incentive to do so. Additional benefits can be realized if trucks only drive at times when they have

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the least impact on traffic levels, making the contract beneficial for both the city and the contracted partner.

At the same time, using the data on whether or not bins are full creates a whole new element of servicing. If people can check in advance whether a bin is full, it enhances the citizen experience while preventing people from leaving rubbish next to full bins. In turn, if citizens have this information, there can be tighter enforcement and penalties for those who leave their rubbish next to a full bin.

Holistic approaches like these can be applied to every facet of city life which connects citizens, devices and services. Through these connections, cities can foster a sense of pride and community that empowers and motivates citizens to take responsibility for ensuring that their city is clean.

4.2 Smart Meters as Motivators to Save Energy

Bruno Morel
Project Manager, Atos Worldgrid

Everybody knows we must manage our energy better, but turning knowledge into action is never easy. To initiate change, smart cities must engage and motivate their inhabitants.

Take smart meters, for instance. We've heard much about how they can reduce energy consumption, but this will only happen if inhabitants are willing to share their data and act on the insights derived. As I will explain below, utilities can help smart cities encourage inhabitants to play an active role in smart metering initiatives.

The smart meter digital dilemma explained

Smart grids are undoubtedly critical to a sustainable energy future. They allow distribution system operators (DSOs) to manage energy distribution more effectively and efficiently at a time when the energy mix is evolving rapidly. Smart meters are one of the smart grid's most critical elements, providing vital real-time insights into energy demand — insights that, incidentally, will also help energy retailers identify new markets.

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Smart meters benefit cities too, contributing to a cleaner environment that is a more pleasant place to live. But how do smart meters improve the lives of inhabitants? Unfortunately, many people feel that these real-time data collectors impact their privacy — a fact which drives one of the "digital dilemmas" facing actors deploying smart metering today.

Since the 2018 implementation of the European data privacy regulations known as GDPR, data privacy has become an important issue for those actors. The challenge they face is twofold: 1.) How to manage personal data to be compliant with the law and 2.) How to encourage inhabitants fearful of the impact of smart meters on their privacy to become active players in their smart metering systems.

Our experience in working with ALEC (Agence Locale de l'Energie et du Climate — the local energy and climate agency) in the French metropolis of Grenoble has revealed a key strategy for overcoming this digital dilemma: engagement.

Reducing energy consumption in Grenoble

Created in 1998 to "contribute locally to the energy transition," ALEC is part of a network of around 250 European agencies acting locally for the global preservation of our environment. It provides energy consumption information to inform the city's building refurbishment and construction programs. To accelerate change across the city, ALEC also needed to motivate inhabitants to reduce their energy consumption. While everybody knows we must manage our energy better, individuals tend not to act — most often because of a lack of guidance and support.

The VivaCité collaborative energy data management program offers a potential answer. An experimental VivaCité platform, run by local utility operators in Grenoble in collaboration with Atos Worldgrid, demonstrates the positive role that such a solution can play in introducing energy changes. In 2019, "Grenoble Metropole" confirmed that it would extend the program in 2020 to cover the entire Grenoble metropolis, renaming it "Metro Energies."

VivaCité recognizes that inhabitants are more likely to take part in smart metering initiatives if they have confidence in the project. It clearly explained the aims of the initiative, along with why these goals are so important and how it hopes to achieve them. It also addressed privacy concerns by demonstrating GDPR compliance, explaining how it manages personal data and, most importantly, allowing inhabitants to manage that data — viewing and deleting it if they want to. VivaCité's web portal has an "About Me" area where any inhabitant with an account on the portal can quickly and easily see all the personal data the system holds about them.

Confident they can access and control their data, and that they are sharing their data for the benefit of the metropolis rather than a private company, inhabitants are more willing to take part. And by engaging in the smart metering initiative, inhabitants benefit from accurate information about their consumption of gas, electricity and water.

Engaging inhabitants so they act

However, the overall aim of the VivaCité portal wasn't to allow inhabitants to manage their data; it was to engage inhabitants in thinking about the future and encourage them to take action for a more sustainable future.

While inhabitants may consume a lot of energy today, in 20 or so years their consumption will be lower. To accelerate this transition, the portal pushed advice to help inhabitants

Sustainability

engage with this vision of the future and act toward making it a reality. Anyone using the portal could quickly and easily access a series of leaflets produced by ALEC addressing real energy and water concerns: saving energy and water and improving comfort in their homes.

The VivaCité platform allows utilities to help smart cities break down the digital dilemmas that may prove to be a barrier on their journey to a greener future. Utilities, cities and their agencies can use it to augment smart metering initiatives to make inhabitants aware of their energy consumption, then push information to them to encourage them to take action to reduce it. After all, encouraging inhabitants to participate is critical to enacting the transition to a sustainable energy future.

Smart metering systems are a critical new digital technology that energy and utility companies must adopt to ensure a more sustainable future. Like other new technologies, smart meters bring new digital dilemmas that neither energy and utility companies nor their smart city partners have ever faced before.

4.3   Water: The most precious asset

Franck Freycenon
Atos Worldgrid

Although we live in a period of massive publicization, the rules which governed the very earliest centers of population still apply: the limits of the water supply dictate the limits of public development. However, for today's water management professionals, the challenges reach far beyond production, transport, storage and distribution.

Water remains the most precious of all our natural assets and the massive increase in demand for water can place an almost impossible strain on resources. Worldwide, we consume around one billion liters of water every six seconds.

Domestic

In our homes, we use baths, showers, washing machines and dishwashers. Domestic metering is not yet the norm in all countries, and most people are more likely to think about power than water consumption.

Industrial and agricultural

Around 70% of the world's water is consumed by agriculture, with industry of every kind getting thirstier. It can take, for example, as much as 4,000 liters of water to produce a single liter of biofuel. Water is also essential for power generation.

Civil

Our cities and civil authorities are massive consumers too, requiring a constant high-volume supply for everything from street cleaning and irrigation to leisure activities.

But it's not just usage which changes.

Climate change

Climate changemeans increasingly rapid swings between flood and drought conditions, with the need to manage the consequences in terms of availability, supply and quality.

Sustainability

Water management authorities need to plan and fund a continual cycle of maintenance and renewal of aging infrastructure — dealing with leaks in parallel with extension into newly developed areas.

Regulation and deregulation create new models of private and public partnership, in which water companies must deliver both service to consumers and a financial return to their shareholders.

Beneath all this activity, one imperative is constant: water supply and water quality must remain of paramount importance. Every water company must ensure that where water is declared potable, it is protected against both accidental and malicious contamination.

From reactive to predictive

In all these activities, the nature of information is changing. Fragmented silos are shifting to big data models. We are moving from reporting to real-time — from the need to gather information after the event to the need to produce current intelligence which is immediately actionable.

The most important element here is to make the shift from "reactive" to "predictive," which will create clear benefits for your company, your clients and for our environment.

► Incidents can be identified and rectified before they become serious and costly to correct
► Continuous analysis of water quality and demand allows treatment to be fine-tuned — saving resources, chemicals, energy and money while lowering health risks
► Customers become actively involved in the service relationship — modifying their own behavior for a better deal and lower peak consumption

To make this change happen, it is important to adopt common platforms, standards and practices.

4.4 Connected buildings

Clara Pezuela
FIWARE Foundation Technical Steering Committee, Atos Research Innovation –
Innovation Lead

Continued population growth and rapid publicization are placing ever-increasing pressure on cities all over the world. One way for city authorities and other providers to maximize scarce environmental and financial resources is to create connected buildings in which every square meter optimizes returns on investment with maximum security.

Automation and analysis

The key feature of a connected building is that it incorporates devices and sensors which, via the Internet of Things (IoT), collect data to manage and control all aspects of the building. Using this data, automated adjustments can be made to lighting, heating,

ventilation, air conditioning, air quality and so on, in response to changing requirements and real-time demand. It is this versatility that makes connected buildings so attractive to investors, owners and operators.

Connected buildings offer all the advantages of minimum energy and utility costs for operators, combined with maximum flexibility and appeal for residents, workers and visitors. Use of space is optimized, which is especially important given the pressure on real estate in many cities.

Sustainability

Data collected from sensors and devices can be integrated with data from other systems in a building (such as climate management) to produce a more comprehensive view. It can be aggregated and analyzed to identify usage trends, set precise "rules" for regulating conditions in the building, predict future needs and identify opportunities for savings and improvement.

Environmental, economic and ergonomic benefits

Perhaps the most obvious — and most urgent — driver for the increasing importance of connected buildings is the environmental efficiency they offer. Connected buildings are designed and constructed to meet high environmental standards — operated and maintained in a way that maximizes energy efficiency and reduces carbon emissions.

There are also economic benefits. A smart and integrated design, construction and maintenance of buildings all reduce the cost of facilities management. The life of buildings can be prolonged because connected buildings are much more easily adaptable than traditional alternatives.

For people that use the buildings, there are many advantages. First, connected buildings are inherently designed to be accessible, comfortable and ergonomic for all users. They keep people safer because, for example, fire risks are reduced and external security threats can be minimized thanks to extensive real-time monitoring and rapid alerts in the event of any kind of incident. Connected building technology is also increasingly used to monitor conditions such as temperature, humidity and static electricity, in order to better understand and ensure health and wellbeing.

Building the case

While there is a broad range of IoT providers and sensor manufacturers in the market using different protocols and technologies, in Atos's experience, anyone considering a connected building should start not with which technology to use, but by defining their objectives and key priorities. These could include decreasing energy consumption, making more economical use of space, or making the building more comfortable. From there, a business case and go-to-market plan can be developed, including what data is needed and how success will be measured.

Not surprisingly, connected buildings are easier to create when they are built from scratch. However, it is possible to adapt existing buildings to become smart. Legacy systems can be integrated and data migrated into a format ready for smart systems.

Strategic assets

While smart buildings have existed for some time, cities are increasingly focusing on incorporating them into the landscape. Many cities are launching public tenders for the provision of smart buildings, especially given the challenges of climate change. More advanced solutions can combine data from the building with data from other sources (such as weather forecasting systems) for more predictive analytics.

With more and more people spending time in shops, offices, transport hubs and other public spaces, connected buildings are a strategic asset for any city authority. Some cities are developing open data portals which store data collected from different sensors in the city and by public administrations. As we look to the future, connected buildings will be an important way to make best use of ever-increasing volumes of data to create sustainable environments while improving quality of life for a city's workers, families and visitors.

Innovation

5 Innovation

5.1 A smart city to drive new business models

Clara Pezuela
FIWARE Foundation Technical Steering Committee, Atos Research Innovation –
Innovation Lead

Multi modal transportation

When one arrives in Málaga, Spain, its stunning coastline, surrounding mountains and friendly locals is captivating. Then something else stands out. Despite being one of Europe's oldest cities, Málaga exudes modernity and digital innovation. Over the past decades, the city has evolved into more than just the gateway to the sunny Costa del Sol.

Revamped and revitalized, Málaga is now home to an exciting culinary scene. The majority of its monuments, restaurants, streets and beaches have been adapted for people with disabilities. Its port is as sleek as it can be, and the city houses a thriving batch of technology companies. The Andalusia Technology Park — one of the leading economic zones in the south of Spain — houses 650 companies and nearly 20,000 employees developing solutions for energy efficiency, public services, communications and tourism. It's no wonder that the city was awarded the title of 2020 European Capital of Smart Tourism (alongside Gothenburg).

Long-term planning

This is the result of the city's smart and innovative vision, which was spearheaded by the 2009 *Málaga Smart City* project and expanded by the city's 2018-2022 Strategic Plan for Technological Innovation. The project encourages the creation of solutions and applications for public life, citizen participation, e-government and open data projects focusing on making the city more innovative, inclusive, technological and smart.

As part of the initiative, startups, SMEs, multinationals, universities and developers have access to the FIWARE platform — and its supporting tools including a generic enablers catalog, video tutorials, guides for developers — allowing them to easily develop applications and integrate city data. One practical example is the electronic display near San Andrés beach, which accurately shows the number of car slots available in a nearby parking area.

Málaga is just one example of how FIWARE is helping cities deliver their digital vision for sustainability, data economy and efficient public service management with solutions ranging from transport and traffic management to waste management. With its open source approach, FIWARE and its growing community is driving the development of smart solutions in a faster, easier, interoperable and affordable way that avoids vendor lock-in.

When solution providers can build solutions in an agile and flexible way on an open platform free-of-charge, financial resources can be deployed on other aspects of business — such as hiring talent, expanding the product line and launching marketing campaigns. Then, there are the technological advantages: the free FIWARE software allows developers access to the source code and enables them to enhance application performance, add features and fix errors for everyone's benefit.

Innovation

Collaboration is at the forefront of the smart city movement

Although FIWARE is all about tech like big data, Internet of Things (IoT) and blockchain, we believe that smart environments can only thrive if public administrations move away from inward, fragmented organizational structures towards highly collaborative frameworks. To deliver seamless public services, these frameworks must include private businesses, not-for-profit organizations, social enterprises and citizens — thus driving the advancement of an information society.

To do so, it is vital that common standards are in place. An important element of data infrastructure worldwide, common standards are at the heart of interoperable platforms and digital infrastructures. By publishing and using data in a standard way, technology users and providers can drive new business models, create open ecosystems and help public administrations to implement policy goals to deliver more effective public services and boost citizen living standards.

Each country has its own goals and challenges, and the word "smart" means different things across continents. However, by establishing sustainable structures and offering new approaches to engage citizens, authorities, local companies and other stakeholders, public service providers can pave the way for economic development and improve the quality of life for their citizens and visitors.

5.2 Delivering on UN Sustainable Development Goals

Albert Seubers
Atos Director, Global Strategy Smart X

In 2015, the United Nations Sustainable Development Goals (UN SDGs) were adopted by all UN Member States as a universal call to action to deliver a series of global socioeconomic and environmental ambitions by 2030.

Integration and empowerment

Balancing social, economic and environmental sustainability, many of the 17 UN SDGs go to the heart of any city's strategy to meet the needs of growing and aging populations, and tackle rises in crime, an increasing wealth gap and air and noise pollution. While the SDGs are naturally interdependent, SDG 11 specifically aims "*to make cities and human settlements inclusive, safe, resilient and sustainable.*" So, how are smart city authorities working towards this goal?
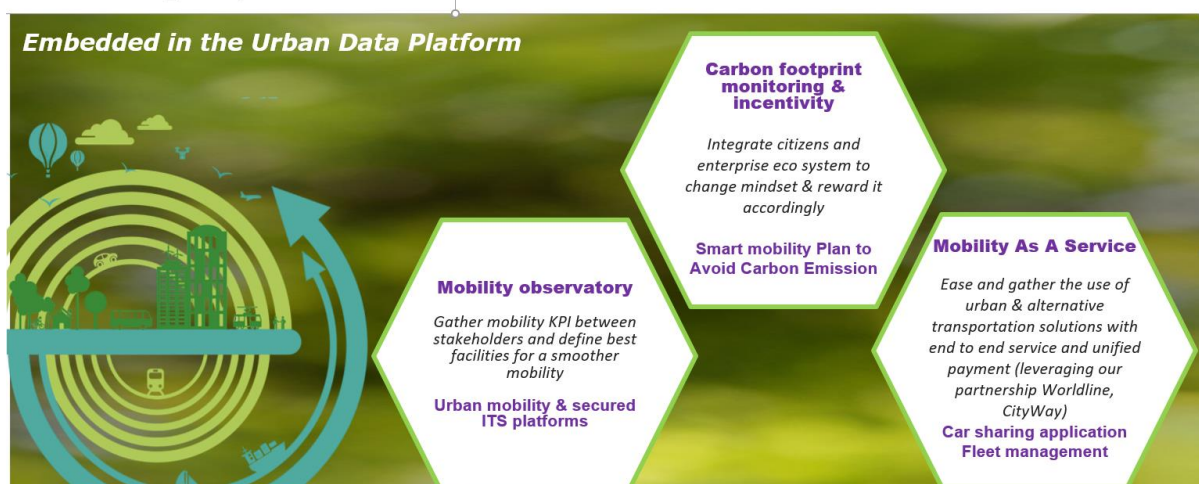
Innovation

Given the scale, complexity and interconnectedness of sustainability challenges, cities need integrated strategies that deliver holistic services while engaging citizens to make better everyday choices. Underpinning these strategies, public data management platforms are required to gather and leverage huge volumes of data from diverse sources. From here, a single, real-time view of the availability and demand for services is available, both for city authorities in their planning and for citizens to access day-to-day.

Integrated mobility

Take mobility for example: a modern integrated mobility strategy is essential to minimize environmental impacts and connect citizens to economic opportunities, education and health services. Essentially, this is about reducing emissions and getting people out of their cars and onto walkways, bikes and safe and efficient public transport networks; and it's about managing the flow of private, public, commercial and emergency vehicles.

Mobility-as-a-Service platforms and subscription services can seamlessly present information about all available options to take a citizen from their doorstep to their end destination — from bus times for the metro, to the platform number of their train, to the availability of a bicycle parked for hire outside the metro station, to the availability of elevators and escalators for wheelchair users.

Smart Mobility :
A strong impact on Decarbonization

Embedded in the Urban Data Platform

Carbon footprint monitoring & incentivity

Integrate citizens and enterprise eco system to change mindset & reward it accordingly

Smart mobility Plan to Avoid Carbon Emission

Mobility observatory

Gather mobility KPI between stakeholders and define best facilities for a smoother mobility

Urban mobility & secured ITS platforms

Mobility As A Service

Ease and gather the use of urban & alternative transportation solutions with end to end service and unified payment (leveraging our partnership Worldline, CityWay)

Car sharing application Fleet management

Lowering emissions

Smart traffic management systems can dynamically prioritize emergency response and commercial delivery vehicles in real time to reduce pollution, lower emissions and increase quality of life. In the case of commercial deliveries, different logistics providers can now

collaborate using blockchain to manage deliveries door to door, including any transfer of responsibility along the journey.

Given the shift in energy use away from oil and gas, e-cars and hydrogen-fueled trucks will increasingly be part of the new mobility mix, again enabled by an integrated strategy and citizen empowerment. One major priority is how to provide the infrastructure for charging electric vehicles at home and in public spaces, including real-time information for citizens on free spaces.

Innovation

Green energy

In every case, as citizens, we need to ask ourselves, *"Do I really need to travel?"*

Such choices and decisions have recently been brought into sharp focus as more and more people have needed to work from home. While employers must ensure that the necessary digital workplace solutions are in place, cities must take responsibility for the establishment of communication network backbones in public spaces.

More broadly, green energy strategies include installing infrastructure for distributing locally produced energy from renewable sources, such as solar panels and local waste gasification, and using data to forecast demand and distribute energy. Citizens have a vital role here and cities need clear strategies to support the implementation of multiple technologies for green energy. Imagine if bio-waste from households could be combined with green waste from city parks and turned into energy at the neighborhood level, and the impact this would have on waste collection and management.

Aiding city planning

At the same time, cities are taking action to minimize the impacts of the built environment on people and quality of life. Given that many different organizations are involved in creating this environment, developing an understanding of the current situation and being able to simulate the broad impacts of different plans and scenarios is highly valuable.

Again, emerging technologies have a key part of play. Spatial computing, for example, combines virtual reality with text, sound or images that enhance the user's understanding and experience. By creating a spatial model of a city, city planners and others can simulate scenarios to understand and analyze the effects of any changes.

Building resilience

There are many different facets of planning the resilience of a city. Flooding and stormwater management has become an important topic, with many cities needing to increase their capacity to absorb rainwater instead of draining it off through sewage systems.

There has, of course, been another major resilience factor affecting daily lives and the economy of cities. Some years ago, Vienna started implementing an early warning system related to the risks of spreading diseases such as measles in order to ensure the necessary health system responses. Now, we have seen that the city has updated this same system to manage the effects of a virus outbreak.

Shared ambitions

With the growing number of people living in cities, integrated public planning approaches, processes and technology platforms must be in place for a truly holistic approach to

delivering clean water, sanitation, energy, food, mobility, education, healthcare, economic opportunity and public safety.

UN SDG 11 is really about the role of cities as hubs for ideas, commerce, culture, science, productivity and social development. A partnership between citizens and city authorities is at the heart of these ambitions; together they can shape the life of smart cities to create positive sustainable impacts and, ultimately, help end poverty, protect the planet and ensure peace and prosperity for all. A data-driven approach is a key enabler to achieve these goals.

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5.3   City-as-a-Platform

Fredric Beckman
SENSATIVE AB – Marketing Manager

Public authorities often struggle to derive the full potential of digital technologies because of the complexities of coordinating multiple organizations and systems. A lack of standardization creates problems with sharing and using data to identify needs, shape new solutions and improve public services. What's more, if cities are locked into particular technologies or vendors, it can stifle innovation and slow down the progress of digital transformation.

IoT: the critical enabler

Collaboration and innovation lie at the heart of the vision of a smart city, which uses digital tools and data to enhance quality of life for residents, business and visitors. Sustainability is key to a modern high-functioning smart city, with streamlining of city functions and the supply of services matched very closely to real-time demand.

To achieve this vision, cities must collect and manage data in completely new ways. The critical enabler for this is the Internet of Things (IoT), where everything and everyone, can be connected and real-time data can be collected and shared with everyone. Yet, the reality is that while the technologies that make up the IoT all exist today, there are several challenges for cities to overcome on their evolution to becoming truly smart cities.

Risking potential benefits

Today there are many connected things in cities. Sensors detect traffic flows; CCTVs capture visual data to monitor people and events for public safety; waste bins can send alerts to centralized collection services when they are full. All this rich information is collected in a highly secure way and processed to deliver a service.

The problem for many cities is that all these systems — although they function in very similar ways — are operating as silos that do not share infrastructure or data. According to McKinsey, without interoperability between systems, at least 40% of the potential benefits of the IoT cannot be realized. This is where a "City-as-a-Platform" solution can make all the difference, by providing the ability for systems, people and organizations across the city to easily share, store and manage data.

Common standards

A City-as-a-Platform is a common platform for the day-to-day life of a city, just as a smartphone is for an individual citizen. It provides a common set of security mechanisms across the city's various operating systems. There are standardized data models (let's call that the "language" that the sensor speaks) and common APIs so that systems can talk to each other.

With these common standards, it's much easier to add a new sensor, organization or service, and data can be joined up and aggregated in a host of different ways to produce new insights and drive new innovations that are perhaps unimaginable today. Different agencies, organizations and individuals can compare and share data in creative ways to collaborate on delivering better, more sustainable and more efficient services for people and businesses. What's more, when different cities use the same platform, data and solutions can be shared between cities.

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Organizational and cultural

Technically this level of functionality and integration is not difficult to achieve. Rather, the challenges for cities are *organizational* — how can cities organize themselves to be able to share and use data? — and *cultural* — how can public authorities and their partners be incentivized to do so?

In the digital age, data is the new raw material for the creation and delivery of effective services and experiences. Creating a digital infrastructure is surely a priority for cities, as is the drive to embrace digital transformation so that city authorities can realize its full value.

5.4 A citizen's key to city life

Tomasz Grodecki
Atos Poland Consulting Manager

New digital technologies can put access to a whole spectrum of city services into the palm of people's hands, helping to make life better for residents and visitors.

Using connected "city card" solutions, public administrations can offer citizens their own personalized card, similar in appearance to a credit card, which can be used to buy and store tickets for public transport and other amenities. As well as the card, a mobile app and an internet portal each provide similar functionality. Multiple operators and organizations can be linked into the city card system, each with its own set of services and data store while still being part of a seamless citizen experience.

A number of cities have already implemented this kind of city card solution — among them, Poznań (a city in Poland with a population of just over half a million) and the region of Małopolska, also in Poland and home to around two million people. Citizens benefit from the speed and convenience of being able to pay for and store tickets and other services electronically. Public authorities have a more efficient way to manage and monitor usage of city services, with data available for analysis to improve planning and future provision.

Multiple devices

Each citizen's city card can become their own digital identifier with their name, address, tickets purchased, information about services used and other data stored for use by different systems and operators around the city. This same information can be held in the mobile app, which brings the added advantage of instant alerts about upcoming events, community news, traffic disruption and other day-to-day information.

Complementing the card and the mobile app, an internet portal is also available with two main areas: a public section for information and gateways to services, and a private password-protected area for each citizen to update their personal details, buy tickets and register for services.

Using public transport

One of the main uses of the city card is for citizens to buy and store tickets for public transport around the city. Given that many cities operate multiple tariffs for different transport modes and routes, city cards can accommodate fixed-term travel cards, single ride fares, non-standard tariffs and each citizen's own customized routes. Regional transport can also be integrated, with the same level of functionality and flexibility.

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Real-time passenger information can be relayed from buses, trains and trams and other systems and displayed on the mobile app and at bus stops, railway stations and on digital boards around the city. This can show precise departure and waiting times, together with timetables, weather details, air quality metrics and other updates.

Sustainable travel

A city card creates opportunities for cities to market a wider choice of environmentally sustainable transport options. Given that many want to promote their park and ride schemes to ease traffic congestion, they can be integrated into the city card to make things as fast and frictionless as possible.

City bike schemes can also be connected so that citizens can easily reserve, pay for and unlock a city bike, and see via their mobile app where bikes are available. This kind of system can also be used to encourage car sharing and promote access to electric vehicles, with an app whereby citizens can hire and charge electric vehicles and plan routes that take account of charging points.

More city life

There are many other aspects of city life that can be brought under the city card umbrella. For example, citizens could use their cards to request waste management services (based on their home address) or register for local government support such as meal services or other social care based on their individual needs.

Residents and visitors could also use their city cards and apps to buy tickets for events organized by the city, with live updates or value-added content via the app, such as QR codes and even augmented reality films as part of their experience. The mobile app, in particular, provides opportunities to promote the city to tourists all over the world and make them feel at home once they have arrived.

Huge potential

Critically, a city card system enables authorities and operators to track the effectiveness of services and use machine learning and analytics to predict and pre-empt future requirements. They are also a mechanism for public administrations to influence important behavioral changes. Loyalty points and rewards can be offered to encourage and recognize certain positive choices, such as using public transport or minimizing waste.

The technology for a city card system already exists, and once a system is up and running, its potential is almost boundless. While full delivery of integrated city card solutions is still at an early stage, they are likely to become an indispensable part of life in many of our cities in the near future.

5.5   Digital devolution: A guide for mayors

External publication, published by techUK.

City regions are faced with a range of challenges, from demographic change, traffic congestion and housing, to improving employment opportunities and local economic wealth. Set against a backdrop of rising citizen expectations and budget cuts, this poses a significant public policy challenge for Mayors. These challenges can no longer be faced alone, and digital devolution presents the opportunity to do things differently.

Elected Mayors can put digital at the heart of their plans and put in place the leadership required to deliver real change and better outcomes. Digital is instinctively designed to

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assist collaboration and, by putting digital at the forefront of city region plans, Mayors can re-shape and integrate services, creating better places to live and drive regional growth.

Key recommendations to the new Mayors include:

Putting in place the right digital leadership

► A Chief Digital and Innovation Champion (CDIC) to be appointed, reporting directly to the Mayor and senior officer of the Combined Authority.

► An Innovation Unit is set-up to work with the CDIC across the city region to foster new partnerships and offer practical support to test new ideas and embed digital across the place.

Becoming a data enriched city region

► A clear commitment from the Mayor to open up data and make decisions based on city wide data.

► An audit of local data assets and city-wide data with the aim of creating a city region datastore.

Innovative and inclusive

A citizen centric approach should be adopted to ensure policies put users at the heart. The Mayor and their team should work closely with the community to tackle digital exclusion.

A destination for talent

A Digital Skills Task Force to be convened within the first 100 days to agree a skills pipeline and put in place the necessary provisions to meet the needs and demand of the community and employers.

Georgina Maratheftis, Programme Manager for Local Government at **techUK** said:

"Digital devolution presents one of the biggest opportunities to do things differently, break down the traditional barriers to service delivery to drive improved outcomes for all. The Mayors, with their direct and convening powers, must use their new and unique position to accelerate the pace of transformation, working closely with public sector, the community and industry to deliver better outcomes for all citizens by creating truly joined-up services and places where citizens want to live and thrive. We are looking forward to working with the Mayors to redefine what a 21st century city region can be."

Aimee Betts-Charalambous, Programme Manager for IoT & SmarterUK at **techUK** said:

"With a trend towards Publicization cities of the future are going to have to work in a very different way to how they work today. Leaders will need to rethink not just essential

services but also determine a strategy for economic growth and improved quality of life. All within the context of budget cuts, resource scarcity and rising expectations."

"This is one of the most consequential periods for city governance and will define the success of our regions in the future. In adopting a digital mind set the new mayors will have an opportunity to enhance local productivity unlocking their share of £208bn in gains over the next decade."

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5.6 Creating a data economy

Albert Seubers
Atos Director, Global Strategy Smart X

In the age of political devolution, cities will be empowered to find new ways to fund local services — and data is a largely untapped resource. In today's hyper-connected world, city services are on a journey of transformation. As more and more public services are delivered online, there is an ever-increasing flow of data across multiple digital channels.

City ecosystem

As cities become data-driven, they can use data to help citizens make informed choices that improve city life, and target city services more effectively. Yet while data can be used in all those ways, it's also an asset in its own right. In fact, in the face of austerity, cities can treat data as a "currency" to fund improvements to city services with minimal up-front investment and risk.

So how can this work in practice? Within the ecosystem of partners delivering services in a city, some are contracted city services providers and others are commercial service providers. In a digitally connected world, these partners can form mutually beneficial multi-sided relationships and agreements using data.

Multi-sided model

This multi-sided model is based on connections not just between providers, but also between the citizen and the city, so that:

► Citizens can choose and pay for commercial services that are offered to them based on their profiles and the data that is shared about them
► Providers of commercial services pay to access and use that data
► Contracted city services partners provide and use data to deliver contracted services, lowering their costs and the cost to the city, which benefits the city, its citizens and the providers

Data as a currency

To operate this multi-sided model, data needs to be made available and shared securely through contracts, apps and smart devices, and through services that are delivered based on shared data. The city can provide access to the data it holds where and when needed, with individual data shared only with active consent from the relevant person. Citizens who sign up for services from the city or contracted service providers can share their data (based on profiles) to enhance the quality or personalization of services. Service providers can pay to access the data. Contracted service providers to the city can grant access to data captured while delivering services (traffic management, collecting waste, public transport, etc.).

In this way, data becomes a currency that is exchanged and used to finance city services and deliver value to citizens and providers. Payment for the systems to support this data economy can be through added value or hard currency.

Changing processes and mindsets

To make the new data economy possible, cities need to start making changes at various levels. Today's service contracts, for instance, are unlikely to contain a paragraph on data. Take waste collection as an example. Waste collection contracts are focused on routes

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per day and the weight of waste collected, with this data provided in regular reports. The data from sensors in bins is used only to optimize the waste collection process and is not shared. Repurposing data about the remaining capacity in each bin could provide new services to citizens or support stricter enforcement of littering.

These kinds of changes require a shift in mindset as well as in processes and systems. By achieving this shift, cities can pave the way for innovative new business models and collaborations to create sustainable, secure and prosperous environments in which communities and businesses can thrive.

A single Cognitive Data Platform will allow cities to maximize the benefits of the data economy, starting with procuring services instead of technology.

6 Return on investment

6.1 An outcome-led approach to financing city services

Albert Seubers
Atos Director, Global Strategy Smart X

Cities today are searching for smart ways to harness technology to solve their most important challenges. Lowering costs and improving public services while attracting more investment cannot be achieved by departments working in isolation. Increasingly, there are opportunities for cities to re-think how they procure and manage different parts of their infrastructure using a more integrated approach.

Holistic approach

Addressing long-term issues sustainably requires collaboration between engaged departments and partners. Many city departments, however, still have a strong focus on procuring technology based on technological functions and price. Instead, departments should collaborate to procure and deliver integrated infrastructure and services around key outcomes.

For example, one city department can only look at replacing existing infrastructure, such as bus shelters. A more comprehensive strategy could involve public safety, street lighting, public transport services and resilient designs to lower the costs of repair and maintenance. The city is better served because existing infrastructure is used or upgraded to achieve a broader goal. The result is an improvement of services beyond an individual department's focus area.

Leading more open partner ecosystems

Orchestrating and reconfiguring procurement of infrastructure and services in this way means that budgets from multiple departments can be pooled and savings on operations budgets can be shared with contracted business partners. This, in turn, attracts more investment from providers and partners — which means the up-front investments (CapEx) for the city will be lower and, in some cases, will provide the option to pay an annual service fee only (OpEx).

Critically, the city needs to remain in a leadership role, with a clear vision for how to procure and finance interrelated city services and infrastructure. For example, sharing data with service providers can help improve services and/or reduce the cost of delivery. In so doing, cities can create more open partner ecosystems and attract more service providers by operating a multi-sided market.

This is explored in the Atos paper Smart city economics: a multi-sided approach to financing the smart city. It is important for the city to take the lead in financing the renewal of services; transparency in the financing of services is what taxpayers demand. Given the complexity of city infrastructures and the array of technological solutions now available, a more outcome-driven vision and approach to procuring city services will be essential to generate savings, alleviate budget pressure and make real changes happen to improve city services

6.2 Spatial computing for smart city planning

Albert Seubers
Atos Director, Global Strategy Smart X

As virtual reality technologies advance, the field of spatial computing is evolving to create new ways for people to interact with and understand the physical world. So, what is spatial computing and how does it apply to smart cities?

In essence, spatial computing combines virtual reality with augmented reality — that is, with text, sound or images that enhance the user's understanding and experience. By creating a spatial model of a city, it is no longer a flat two-dimensional object on a computer screen; it is a three-dimensional virtual world that users can inhabit in "mixed reality" mode.

Mixed reality simulations

Spatial computing enables city planners and others to interact with parts of the city and simulate scenarios in order to understand and analyze the effects of any changes. For instance, when a city planning department wants to add to the built environment of the city, researchers and engineers must study the impacts of the planned changes on the city and its citizens. Traditionally, this would have required them to prepare large sets of detailed documents and calculations that may only have been understood by a select group of people and could go out of date over the course of the project.

Today, architects' plans and drawings are usually accompanied by virtual models that showcase what a new building will look like in its intended location. Spatial computing goes one step further, by presenting the building and its surroundings as mixed reality. By combining virtual models with existing data, the construction of the new building and other changes can be simulated to identify impacts on the environs and on people. For example, if data on current noise pressure, air quality, etc. has been gathered and stored, it can be used in a spatial computing model in combination — for example, with sound reflection/absorption rates of the proposed design and construction materials. The impact of a new building on natural air flow can also be visualized, showing any effects on air quality or possible heat spots.

Critical public infrastructure

Spatial computing makes it possible to drill down deeper into the details of a building and "peel off" layers to reveal its infrastructure. As long as it is kept up to date, this information could save lives — in the event of a fire, for example.

Spatial computing can also be used to visualize waste and water infrastructures or power grids. In these cases, before any maintenance or construction work begins, workers must have a good understanding of the location and composition of existing infrastructures and networks. Emergency or unexpected events can be simulated, such as a water pipe breaking or a power line going down, to prevent damage or interruptions to utility supplies. Simulations can also be run for other public safety requirements such as transport networks or crowd control.

Return on investment

So, should every city have its own spatial computing model? I would say yes. The next question is then, of course, "How can this be affordable, developed and maintained?"

Return on investment

One option is for the city to outsource the development and maintenance of its spatial computing model so that it is effectively maintained and future proofed. Ensuring that accurate and complete data is available in the right format is critical to ensure that the outputs from the model are valuable.

If cities make full use of a spatial computing model, it will pay off; for example, using a spatial model to calculate and charge for the appropriate building and planning permissions. Given correct and sufficient data, a spatial computing model will deliver measurable benefits when it is applied to the right use cases — and the more times it is used, the greater the return on investment.

7 Safety and security

7.1 A city for citizens

Albert Seubers
Atos Director, Global Strategy Smart X

While many reports and discussions explore the concept of the connected citizen by focusing on a specific aspect of day-to-day life, few focus on what "being connected" means for the citizen as an individual.

Connecting communities

The ability to access online eGovernment services such as paying taxes, applying for permits and so on is a form of connected citizenship. The focus here is on easy access to processes and information, often to save costs of delivering public services.

Connected citizen programs that focus on traffic flow and energy consumption levels provide the data required to update citizens who are connected via dashboards or apps. The connected citizen could also mean membership in online communities or social media, or participating in the education system by enabling children to do homework online. In this case, "connected" means prioritizing spending on devices and connectivity above other family expenses. In many of these examples, the citizen is connected via the smartphone they carry. As the number of smartphones keeps rising and mobile networks expand across the world, this "connected citizen" model becomes more powerful.

Just remember the crisis in Haiti in 2010 and the Philippines in 2013, when mobile connections with citizens enabled rescue and crisis management operations to start rapidly.

Reaching more widely

For me, the connected citizen is also the citizen who may have no smartphone but needs assistance, such as elderly people who are living independently for as long as possible. I know that many elderly people already use smartphones and this number will only grow, yet a smartphone may be out of reach at the moment they really need help. This is where other means of connectivity should be available (and I don't mean by implanting chips). Older people, vulnerable people and those with medical conditions should be able to get connected so vital information can be shared through a secure connection that can vary depending on location, type of information and network availability.

Connectivity can be through wearable devices or sensors embedded in the steering wheel of a car, for example. A device could even be designed as a piece of jewelry, so the person carrying it is not instantly associated with it. Data from the connected person can be captured and monitored constantly, prompting immediate responses to provide personalized care by the most appropriate provider. In this way, cities can provide more personalized care at lower costs to citizens in need of support.

Today, elderly people who need to be connected are often confined to their homes because that is the only place where connectivity can be provided. This situation will soon change. Cities can also benefit from the data captured, which might reveal — for example — that traffic or transport systems are not suitable for all citizens.

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Ensuring trust and security

As always with connected citizens and smart cities, "data" is the keyword that triggers questions about privacy and security. Who can access the data? Can we always trust the data, since sensors may malfunction or networks might not be available? What actions can be triggered?

Data therefore must be monitored and used in the context of the citizen's profile, triggering actions accordingly and notifying the people who can provide help. Secure data collection can be ensured through devices such as wristbands that authenticate the wearer by using their heartbeat — an innovation that is already on the market to help people who need support.

Being a connected citizen has many different facets. We each must be able to create our own way of connecting — possibly through multiple technologies and networks — to ensure we derive personalized benefits in an appropriate, trusted and secure way.

7.2   A data-driven approach to public safety

Albert Seubers
Atos Director, Global Strategy Smart X

Today's cities face the competing demands of squeezed budgets and the need to keep citizens safe in a time of growing and changing social pressures and security threats.

At the same time, the digital transformation of city services and the explosion of social media and surveillance systems is creating vastly expanding volumes of data. By harnessing and linking that data, cities can address the very real challenges they face in keeping communities safe and secure.

Intelligent policing

Using more responsive, real-time technologies, local police can respond to alerts and incidents more quickly and enhance citizens' feelings of safety. The digital transformation of policing and the availability of data from multiple channels means that intelligence can be extracted and delivered to officers wherever and whenever they need it.

More timely sharing of appropriate information within the police service and across city departments means that citizen issues can be dealt with more rapidly, repeat work can be reduced and incidents that don't require police can be redirected earlier. A smart use of data enables police services to react more swiftly to crime, creating a more predictive, proactive and pre-emptive police response.

Safety on the roads

Ensuring citizens' safety is about more than policing and fighting crime. Equally important is traffic safety, such as identifying potentially risky situations and enforcing regulations such as speed limits.

Information based on real-time monitoring of traffic flow, traffic incidents, planned road work and external factors like the weather means that citizens can take make informed decisions even after their journey has started. To prevent congestion, this information should include predictions on the impact of incidents, updates for drivers on alternative routes and modes of traffic. In addition, city authorities can give warning signs to drivers by making streetlights blink or change color when needed.

Safety and security

Real-time surveillance

In the Dutch city of Eindhoven, an innovative initiative called CityPulse combines existing sources of information such as the analysis of pedestrian walking patterns from surveillance cameras and the analysis of sound spectrums and social media to create a holistic, real-time picture of what is happening on the streets.

Big data analytics ensure that any anomaly outside a "normal" data pattern can be cross-referenced against the other data sources. If these data sources confirm an incident, the CityPulse dashboard alerts the police control room so that they can make informed decisions. Early warnings are triggered for incidents that require intervention, ideally to de-escalate them before they develop.

Connected cities

Looking forward, as cities become more connected through the Internet of Things, next-generation 911 systems will respond not only to phone calls, but to alerts received through connected systems, social media and other sources. Communication from the dispatch center to members of the public and police, fire and ambulance services will be pushed through multiple channels to ensure that all relevant parties are reached quickly. In future, citizen alerts could also be triggered through use of an LED streetlight system.

Today, many of the technologies capable of harnessing data to deliver a real-time, connected approach to public safety already exist. What is needed now is digitally enabled transformation and collaboration to integrate and share data more effectively. This will enhance the citizen experience and help city services more effectively protect communities in an increasingly unpredictable and fast-changing world.

7.3   Privacy by design: Securing a data-driven city

Albert Seubers
Atos Director, Global Strategy Smart X

While each smart city evolves in its own way, what they all share is their critical ability to leverage data to enable people to make better-informed decisions. However, with information and intelligence shared extensively between city authorities, third parties and citizens, it must be done in a way that protects and maintains the privacy of citizens.

Privacy by design

Some time ago, I was involved in a project to collect data from cameras located across a city and analyze it in real time to alert the police and other authorities of potential disruptions. In designing the solution, we followed the strict principles of "privacy by design," which mandate using only minimal data sets — that is, not capturing or storing any more data than you need — and always anonymizing data.

In this case, the data analytics were applied at the edge (within the camera itself) and people were presented only as red dots on a map so their movement patterns could be analyzed to indicate potential incidents. This solution ensured that the authorities had the data they needed for rapid decision making without invading citizens' privacy.

Accessing and controlling data

Of course, in a smart — or data-driven — city, the really "smart" thing is to be able to structure and organize the same data for multiple purposes or use cases. To achieve this, data is collected from multiple sources (such as video cameras, sound detection sensors,

waste bin sensors, etc.) and stored in "lakes" of data, with each data lake relating to one specific use case. For example, if a camera detects a car entering and leaving a parking lot in order to calculate how long it was parked, it may also collect the car's vehicle registration number — but this will be stored in a different data lake for a different purpose (such as administering road or vehicle tax).

Collecting and using data in this way requires that data is anonymized either by being analyzed at the edge (as in the video example above) or de-identified when it is in motion (just as with any kind of online money transfer). It also requires data access to be strictly controlled to prevent any breaches of privacy, such as ensuring that a picture or profile of a person or object cannot be built up over time by assembling individual pieces of data.

Holistic solution

An integrated end-to-end technological solution and governance will address every one of these requirements to ensure the availability, integrity and security of data in a smart city. Artificial intelligence and automation ensure that each data lake is only accessed and used for its intended purpose. Context broker technology ensures that the source and timing of each piece of data is known in order to understand its value, meaning and urgency. Secure IoT services ensure the flow of data across the connected city. Edge computing provides enough power to process and analyze data out in the network. Identity access management solutions — including two-factor authentication — ensure that access to data is strictly controlled, with a clear audit trail.

Changing perceptions

To deliver this type of integrated solution, an end-to-end cybersecurity strategy is essential to prevent cyber attacks and data breaches. Yet it's not just cyber incidents that need to be pre-empted and managed: events such as power outages and accidents can affect data flow, which is why cities need a bridge view (from a central operations room) of their sensor networks to gain visibility of how and where all data points are working.

Inevitably, city leaders, technology partners and others are having ongoing discussions about what's possible when it comes to maximizing the value of data within accepted ethics and privacy limits. Yet, with the right technological expertise and infrastructure, it is perfectly possible to ensure privacy by design. If citizens see the value of leveraging data while knowing that their privacy is protected, public perception can shift to see the benefits of devices such as surveillance technologies and accelerate the evolution to a truly data-driven city.

7.4   Safety on the streets with new video intelligence

Eric Monchalin
Atos Vice President, Head of Machine Intelligence

With thousands — if not millions — of people on the streets of a city every day, the primary concern of that city's public authorities will always be to keep those people safe. It should come as no surprise, therefore, that video surveillance has become a critical tool for the police and other agencies. At the same time, there are public concerns about the role of surveillance in modern society and how citizen privacy will be protected.

Crucial assistance

The reality is that while there may be thousands of cameras positioned in public spaces around a city, the pictures they capture are monitored by only a handful of operators. Keeping watch on all that visual information in real time and making best use of it during

an incident can be a huge challenge. Now, digital capabilities can make a dramatic difference, giving operators crucial assistance to focus their activities on events that require their immediate attention.

Incorporating powerful machine learning and data analytics, a solution called video intelligence means that operators can now monitor the movements of an individual from camera to camera, and even predict where they will go next. This can be done in two ways: by helping operators quickly locate and follow a particular individual; or by enabling them to choose to follow an individual who is behaving suspiciously.

Lower crime, higher public confidence

In cases when a person needs to be found very quickly, such as a crime suspect or missing person, they can be pinpointed either by what clothes they are wearing or by using their photograph. In cases where a person seems to be behaving unusually, the operator can click that person on the screen, then follow them as they move around. In all cases, the operator gets a unified view of the individual's movements; from there, they can decide to stop following, continue following, or send an appropriate person to an exact location to intervene.

With video intelligence already live in several cities, the benefits include lower crime rates — because people can be located and apprehended much faster, plus higher levels of public confidence — because the authorities' responses can be swift and precise.

Maintaining privacy

What does all this mean for citizen confidentiality and the use of personal data? In fact, video intelligence is fully compliant with data protection regulations, with no implications for the individual's right to privacy. There is no facial recognition and all data and visual information is anonymous. There is no intention or ability to identify individuals, and data management rules are fully compliant with security policies for the use of video and for the city as whole.

Let's look at an example. The city authorities have received an alert about a lost child. Based on the parents' description of what the child is wearing, an operator opens up their video intelligence app, enters the clothing details, quickly finds the child in a crowd and follows her from camera to camera while a police officer is rapidly dispatched to the scene to ensure the child's safety. There is no matching of any information about the child to any database, no correlation of any other information about her, and no long-term storage of information about her.

Technological advances

In addition to machine learning and analytics, what makes this kind of dynamic monitoring possible is real-time computing at the edge (that is, close to the camera itself). This means that the analytics can be generated rapidly, and cameras can communicate with each other to follow individuals across public spaces. With technologies advancing constantly, in the near future it will become possible to combine visual data with sound for an even richer real-time understanding of events.

Perhaps what is most interesting about this kind of technology is how it augments human intelligence rather than replacing it. Operators are still a critical part of the process: they just have the huge advantage of AI to help them focus more efficiently and make the timely, evidence-based decisions.

Safety and security

7.5 Artificial intelligence supporting emergency management in public safety

European Emergency Number Association

The vast potential of AI is starting to be unleashed in many walks of life and the public safety domain is no exception. Image and text analysis, speech recognition, chatbot interactions, and machine learning models all have applications for public safety and security organizations.

First, AI in the form of robotic process automation can be used to complete repetitive tasks and free humans up for higher-value work, just as it has in other sectors. AI can also be used to process vast amounts of data, finding patterns and new information that might otherwise have remained unseen; this can help, for example, in video and voice recognition. In addition, the rapid growth of the Internet of Things (IoT) is now creating opportunities to integrate sensors into Public Safety Answering Points which, when coupled with analytics at the edge (within the device itself), can increase the visibility and understanding — the situational awareness — of what is happening on the ground.

So, which public safety domains are exploring the benefits of AI and what are the different applications?

Enabling and supporting firefighters

In Catalonia, Spain, an award-winning AI-based platform has been developed to monitor and act on data about firefighter health and safety both in real-time and over the long term; this solution will soon be tested with firefighters. Elsewhere, AI can be used for more effective, and predictive, management of vital operational asses such as firefighting equipment and protective clothing by predicting demand and providing rich data that can be analyzed to inform future asset procurement and maintenance.

AI-enabled technology can also assist with early fire detection and decision support, for example using visual recognition AI from surveillance cameras and other data sources to detect fires in forests, natural parks and even mining areas and industrial facilities. In fact, AI has an important role to play in identifying, prioritizing and mitigating all kinds of crises and disasters, from storms, floods, and earthquakes to drought, extreme heat, epidemics and wildfires.

Medical emergencies and law enforcement

In the clinical domain, AI can now be used by emergency medical services to diagnose injuries in real time; let's take a car crash as an example. With data available from the car about the exact duration and type of impacts to passengers, this could be transmitted and translated into a medical report in real time, which could, in turn, be sent automatically to emergency medical services to dispatch an informed and appropriate response.

In law enforcement, video surveillance is much more effective at detecting and preventing crime using AI-enabled human and object detection and tracking combined with a knowledge base and behavior analysis, especially in situations involving crowds, abandoned objects, searches for persons of interest, and so on. Both London's Metropolitan Police Service and the South Wales Police have tested the use of automated

facial recognition technology at public events such as concerts, festivals and soccer matches.

An ethical framework

Use of automated facial recognition has been the subject of some debate about threat to people's privacy and right of association; this is one in a number of areas of public concern, such as people's loss of autonomy or lack of clarity about how algorithms are programmed and used. It is, therefore, critical to design guidance to ensure trustworthy and fair use of AI. A robust ethical framework and laws are required to ensure that algorithms are deployed in a transparent and explainable way and are never biased against gender, racial or social status.

Let's not forget that while AI is a valuable tool, the autonomy of people must always prevail over the technology. AI is there to augment, not completely replace, human decision-making and the "super-system administrator" must be a human being. At the dawn of this new technological era, there are many exciting applications for AI in public safety. Through innovation and collaboration — between public safety organizations, technology partners, lawmakers and others — these capabilities have the power to help make our world a safer place for all.

7.6 Integrating social media into an emergency response

Iratxe Gomez
Atos Expert in Public Safety

It's widely recognized that social media is now a way for authorities to interact with the public. Police forces, local governments and other agencies turn to Facebook, Twitter, Instagram and other social media platforms to reach communities every day and in times of crisis. In emergency situations, public agencies use these channels to communicate official and verified information as quickly and widely as possible while monitoring events to inform their response.

Upward trend

In these cases, however, the challenge for authorities — and for members of the public — is how to deal with either a lack of reliable information or information overload. Perhaps that's because until now, social media channels have not been fully integrated into authorities' emergency responses. Yet all this is changing.

Emergency response organizations in several countries have been calling for the growing trend of social media to be harnessed more effectively as part of public sector emergency management. During recent terrorist attacks, for example, citizens quickly started posting online as soon as events started to unfold. For young people in particular, social media is today's channel of choice. While they may not think of making a phone call, they will be ready to post a message, photo or video in an instant. What's more, there are some emergency situations in which people may be unable to talk on a phone — in a hostage or terror incident, for example.

Systematic integration

Therefore, it is important in the digital age to more systematically integrate social media channels into emergency management workflows and systems. Any form of alert or message from a citizen via social media could trigger the process of dispatching resources, so public authorities need a robust way of detecting actionable information in real time. A Facebook/WhatsApp post that includes details of a particular gathering, or a Twitter/

Instagram message with a picture of a fire could be the official trigger for an emergency response.

Once the incident has been reported, social media could be used seamlessly with other systems to monitor the incident and gain a more dynamic, complete operational picture of what is happening than would previously have been possible. Visually, the authorities can gather vital intelligence to decide, for example, where to send resources and target help — where crowds are gathering, the position of an attacker, where injured people are located, and so on. And of course, once resources are on the ground, the authorities can send up-to-date public warnings and messages to the media.

Powerful technologies

While social media has a role to play at every stage of an emergency situation, it also brings challenges — not least of which are the vast amounts of data available in a variety of formats. What's more, authorities must distinguish between people who are present at the site of an incident and those who are reposting messages, or even individuals who are spreading disinformation.

This is where artificial intelligence (AI) can be deployed to filter large volumes of mixed data and to process and analyze reposted messages and pictures. While some countries are farther ahead in this area than others — France is a leader in the use of social media in the public domain, for example — public authorities everywhere must integrate these channels into their systems. This is important not only to keep up with societal trends, but to harness the full power of digital technologies and data to deploy the most proactive, targeted and adaptive response possible.

7.7   Safeguarding citizen services: A new vision of cybersecurity

Albert Seubers
Atos Director, Global Strategy Smart X

One night in April some years ago, more than 150 emergency sirens blared for hours across the city of Dallas. But there were no tornadoes on the horizon. Texas was not being invaded by aliens or coming under attack from zombies. Instead, unidentified hackers had found their way into the city's IT systems and decided to set off all the sirens — apparently just for fun.

What may seem like a harmless prank actually raises very serious issues for public administration. Simply put, how will the residents of Dallas ever trust the sirens again? From now on, will they just assume that hackers are at work? Will they ignore the sirens, possibly with terrible consequences?

With just one cyber attack, decades of trust in a vital public service was lost overnight.

That is the major cybersecurity problem now facing city authorities and national governments. As more and more citizen services move online — from paying taxes to finding parking spaces to booking medical appointments — our vulnerability to attack is increasing exponentially. Just one successful cyberattack can destroy the reputation of a service and undo years of hard work and investment.

Imagine if criminals hacked into a navigation app to divert traffic and cause chaos in the streets; or if hackers used a malware worm like WannaCry to take down a city's entire IT network. People who rely on the network for public assistance payments or healthcare services would be completely cut-off with nowhere to go. They would never fully trust the city's services again.

Safety and security

To avoid such a catastrophe, cities must adopt a new, holistic approach to cybersecurity. It's not enough to attempt to protect an organization's perimeter with firewalls. There must be a proactive attitude, based on assessing and monitoring risks, protecting services against known vulnerabilities and threats, and anticipating future threats.

Cybersecurity is no longer only about protecting national secrets and military institutions. It is about safeguarding our everyday life as citizens.

A 360-degree approach to cybersecurity

As a first step, public organizations must understand the specific risks they face and how to protect critical assets from attack. Data security solutions for **preventing attacks** include anonymization, encryption, and ID & access control, as well as services such as [detecting advanced persistent threats](link) (APTs). On the **detection** side, increasing numbers of organizations are now using the services of security operation centers to carry out real-time monitoring. These centers deploy sophisticated behavioral analytic tools to pinpoint potential incidents in real time. When it comes to **response and remediation**, public bodies are establishing cybersecurity incident response teams to coordinate effective and efficient decision making that can neutralize attacks and respond to evolving threats.

These three elements need to work together to form a **continuous cycle of improvement**. Cyber threats are evolving all the time, becoming more determined and more sophisticated. Public organizations must make sure they stay one step ahead as they invest continuously in developing new services for their users.

Finally, it is important for citizens to be informed that their data is being used to power new services, and educated about how to act responsibly to protect their devices and data.

Powering public services

Data is the new currency of the digital age. Powering a new era of online services, data is becoming as important a utility as water, food and electricity. Cybersecurity is the key enabler of this revolution. As consumers, we already trust the likes of H&M and Amazon with our personal data when we buy clothes and books online. We now need to develop the same level of trust in online citizen services.

In the public sector, however, the stakes are much higher. If your book or coat is delivered late because of connectivity and encryption problems it's a minor inconvenience, but losing a patient because of a Denial of Service (DoS) attack would be a disaster for any healthcare authority. The development of citizen-centric digital services is raising the bar for cybersecurity. People must have complete trust that their personal data is being protected and secured, or they will not use those services.

Cities employ an open data approach, sharing data from various sources on one platform to develop new citizen-centric services in complete security. These services are enhancing the quality of public life, improving public administration, and providing greater safety to city residents.

For example, consider a solution that makes the streetlights flash blue when there is a sudden deterioration in air quality — such as following a fire at a chemical plant. The lights are securely connected to air quality sensors using IoT technology. Previously, it would have taken hours for the fire services and other authorities to organize a city-wide alert. Now, a potentially life-saving warning can be issued almost instantaneously.

Safety and security

With data volumes growing exponentially, the main challenge is not to combine the right data from the right places, but to secure these increasing volumes of data and make sure that the data is available 100% of the time — only to the right people.

However, if the hypothetical streetlights above flashed blue just once because of a hacking attack, people might never believe in the system again. If the brave new world of digital innovation is to fulfill its potential, citizens must have complete trust in these solutions. The mission of cybersecurity is to enable that trust, and safeguard a new era of citizen-centric public services.

7.8 Public safety and crisis management service orchestration

Egbert Jaspers
CEO, ViNotion

A key challenge faced by city operators, municipalities and political decision makers is the fragmentation of information into vertically oriented closed systems and siloed organization models.

The PS-CRIMSON (Public Safety and Crisis Management Service Orchestration) project aims to overcome these challenges by delivering an integrated 3D digital model and information platform that facilitates information collection, sharing, management, analysis and dissemination from diverse public and private Public infrastructures and resources. The PS-CRIMSON platform supports public authorities to improve quality and efficiency of municipal services and enhance their resilience in the presence of adverse conditions. Furthermore, adequate security and authentication methods allow selected Public data sources to be exposed to the full smart city ecosystem, which is a key enabler for the development of innovative data-driven applications and services stimulating economic activity and supporting job growth.

The PS-CRIMSON platform will bring together the visually oriented, intuitive nature of Geographic Information Systems (GIS) and the highly dynamic real-time contextual data streams that are made accessible through interoperable ICT-backends of public and private Public infrastructures. Augmented with 3D city models and visualization capabilities, the PSCRIMSON information platform provides unprecedented situational awareness that improves operational decision making and allows procedures and planning to be evaluated.

The benefits of service orchestration through the PS-CRIMSON platform will be demonstrated in the context of three closely related use cases: *crisis management*, *public safety management* and *disaster management.* These demonstrators will be hosted in Istanbul, Eindhoven and Vancouver.

With contributions from Canada, Turkey and the Netherlands, the PS-CRIMSON consortium is composed of partners that cover the full market value chain of Public data providers, platform providers and application and service providers. The consortium composition carefully balances the scale and impact of large industrial partners providing and operating major Public infrastructures and platforms with the in-depth expertise of academic institutes and the innovative power of selected SMEs.

The project PS-CRIMSON was awarded in September 2020. Further information can be found in the press release: https://itea3.org/press-release/press-release-a-one-look-overview-of-the-city-in-5-seconds.html.
Additional information about the project can be found on the PS-CRIMSON webpage: http://www.ps-crimson.com/

8 Caring, healthy cities

8.1 What's good for me is good for you

Albert Seubers
Atos Director, Global Strategy Smart X

The caring city is competitive

The 2013 Caring Cities forum in Johannesburg examined many pressing issues — not just within Africa, but to cities and communities everywhere. This was expressed through the idea of "public Ubuntu" — sharing and social responsiveness as a key to growth. As public thinkers, we can learn powerful lessons from South Africa's organic and innovative responses to growing public challenges. Chiefly, it shows how putting a holistic idea of "care" at the center of our cities can improve infrastructure, services and competitiveness of the city as a whole. Perhaps it's time to look at why care is so important as we enter the age of the city.

We are in a period of unprecedented public development in which we can take part and make real change, as citizens and by creating more connected and integrated services for everyone to use. Propelled by the integration of services, better IT and communications and a need to ensure the best use of resources, we see more than ever true public interdependency where integrated care services like health, social, housing, age care and others focus on improving quality of life *as an inescapable part of competitiveness.*

How can we, as people and city thinkers, help accomplish this? Perhaps by examining the principles of public Ubuntu, we can create more responsive services that share wealth in the right way to create the community we all want and need.

► Our approach to delivering care services must be simpler, more efficient and more cost-effective. Using current technology, we can align improved care with relatively simple changes to treat all aspects of care as one — focused on people within the community, instead of whether or not someone qualifies as a patient or subject of care.

► By integrating areas that many cities often treat as distinct silos into a single service (with a unified interface) that treats each citizen as a "care system of one," we ensure that nobody falls in the gaps, and that structured and unstructured information can be used to gain insight into people's lives and needs in order to catch problems earlier. Removing the silos that keep health and social services separate can save the city money and time. We can, in effect, square the circle, enabling efficiency and care simultaneously — putting an end to the myth that care always must be expensive. In fact, this is the pathway to a healthy city.

► Let's embrace what we might call a full "digital health" agenda. While overtly technological solutions to healthcare are often debunked in current media, we will see continuing and unavoidable movement towards full digital health solutions. These services employ digital interfaces to prioritize treatment by professionals and aid in self-diagnosis for other cases, filter out simple cases, and use care resources on higher-priority cases. They both cut costs and increase speed of service while creating better care for citizens, because doctors and care workers can concentrate on areas of real need — guided by automated dialogs between care systems and citizens.

► Finally, it's important to look deeper into the future needs we must address. This includes embedding new thinking for elder care and better preventive healthcare for chronic and age-related problems as part of service provision. By providing better

nutritional advice and self-care programs that encourage citizens to live better and be happier, government will be able to care for them more effectively.

What connects all these ideas? Most importantly, the notion that "care" and "efficiency" are the same — just as care and competitiveness are inextricably linked.

Digital technologies can enable — not prevent — holistic care, by connecting services, enabling care professionals to understand and cope with the changing nature of their communities' needs as well as how service investments and technology development is directed.

By connecting efficiency and holistic care within our public environments, we will create our own Ubuntu. Doing so ensures that the future of people will be brighter, their productivity realized over a longer time frame, and they will be happier and safer as well.

8.2 Using data to deliver more targeted health and social care

Albert Seubers
Atos Director, Global Strategy Smart X

With demand rising for health and social care in cities, taking a data-driven approach can help reduce pressure on services while targeting precious resources more effectively.

Increasing demand for health and social care is the result of both an aging population as well as high-density populations and infrastructures — meaning that stress levels are on the rise, causing many kinds of issues.

Encouraging health and wellbeing

While cities cannot enforce healthy lifestyles, they can promote them by empowering citizens and providing them with positive opportunities. From a design perspective, more open space (preferably green) is needed to help provide clean air and time to relax.

The City of Copenhagen is a very good example of this. Within 15 minutes on foot or by bicycle, every resident can reach a park or waterfront. The City of Houston also has a very well-designed riverside park where cycling, running and other types of sports are welcomed.

In some cities, people are attracted into parks through partnerships with private-sector sponsors providing technology to promote and enable sports and exercise. These technologies generate and capture data (via wearable devices, for example) for use by individual citizens as part of their own health and wellbeing regimes, as well as by sponsors and city services to more accurately plan and target resources.

Personalizing health and social care

Aging also has an impact. As we grow older, we want to live independently for as long as possible, which creates increased demand for home and health support. This is in the interests of city services, for whom the costs of elderly and retirement homes are high.

Home support services are provided by commercial companies — sometimes contracted by the city and sometimes directly by residents. Currently, the services delivered are usually dictated by the availability and schedule of the provider. In contrast, access to biometric data can help personalize services for individual citizens much more effectively.

Caring, healthy cities

Wearable technologies can capture such data, with highly secure connected bracelets that provide real-time data on vital functions to a care provider's dashboard. There are other uses for such data — for example, analyzing captured heartbeat and blood pressure data to help city planners identify traffic situations that are particularly challenging for elderly or disabled people. A wearable device could even trigger the lights at a pedestrian crossing to allow the wearer more time to cross the street.

Multi-agency approaches

Delivering targeted and timely social care in a city means breaking down silos of data held in different systems. Combining data from social services with police records and education service systems can trigger alerts about vulnerable or potentially vulnerable individuals and families who need help. Of course, privacy must be taken very seriously. The results of the analysis must be presented in a way that protects data and privacy, with training for city workers who receive the alerts.

In a ground-breaking collaboration in South Wales, five public service organizations are working closely together to identify people who may be vulnerable and who may benefit from multi-agency support. Local councils, a health board and the police all share information through innovative data-matching, predictive analytics and consultative dialogue to identify individuals and groups most at risk — who can then receive earlier, better-targeted help and interventions. In some cases, this can even prevent vulnerability happening in the first place.

This is just one example of what becomes possible when agencies start to collaborate. Across the range of local authority health and social care, it is critical that cities provide the digital framework for an ecosystem of services and tools that empower citizens and enable agencies to work together to deliver better targeted, more integrated care.

9 Mobility

9.1 Increasing mobility: A data-driven approach

Albert Seubers
Atos Director, Global Strategy Smart X

With mobility in cities under strain, citizens can play a major role in addressing problems if they have access to the right data. The pressure on mobility in cities is growing. A combination of factors is contributing to this, including population growth and evolving retail strategies.

Pressures on traffic

These days, it is simply not cost-effective for retailers to store goods in expensive city-center retail space, so replenishment deliveries must happen more frequently. When combined with the growing number of distribution companies fulfilling online orders, this significantly increases traffic density.

As citizens, we also play a part in these growing pressures. Many motorists choose to use their cars and park where it is easiest and most convenient for them, instead of using alternative transport and parking options.

Informing citizens

If data about current traffic situations, parking availability and alternative transport options can be captured and presented in a single, readily accessible view, it can enable citizens to make better-informed choices to change their travel plans in real time. Of course, only a proportion of the population has the luxury of deciding not to travel or changing their travel times — but only a 10% reduction in cars on the road will reduce congestion to nearly zero.

Reducing traffic flows

Information based on real-time monitoring of traffic flow, traffic incidents, planned road work and external factors like the weather means that citizens can take make informed decisions even after their journey has started. To prevent congestion, this information should include predictions on the impact of incidents, updates for drivers on alternative routes and modes of traffic. In addition, city authorities can give warning signs to drivers by making streetlights blink or change color when needed.

Switching to an alternative mode of transport must be easy and convenient — such as the ability to us a single bank card, credit card or city transport card to access and pay for national rail, local rail, parking, bicycle sharing, etc. Value-added services that support positive shifts in transport patterns will encourage beneficial behavior changes, such as valet parking, discounts on combination tickets for park & ride — even a parcel drop-off service or deposit boxes at the park & ride. The City of Poznan, for example, has issued over 320,000 city cards that enable residents to access public transport along with other city services such as the library. As such, the city card acts as a community card with a loyalty scheme, a central element of mobility and city services.

Improving parking

While "smart" parking solutions are part of many smart city projects, reducing congestion is often best achieved by completely removing parking options, encouraging drivers to

use park & ride lots or offering other modes of good-quality transport. In Singapore, clean, low-cost public transport is always available, giving citizens options just as appealing as their own private transport.

Keeping a city mobile directly impacts air quality, so energy transition in transport is also important. While electronic vehicles don't reduce congestion, they do cut environmental pollution. These require more charging stations to be available across cities, which also function as parking spaces. From a grid perspective, it is interesting to combine charging and generation by use of solar, for example.

With many new developments (including autonomous vehicles) being tested, all planned investments in parking and road upgrade programs should be reconsidered. They must become part of a more integrated data-driven city vision and strategy — with the infrastructure and culture needed to exchange data and empower providers and citizens to make choices that improve daily life in the city.

9.2   Smart city parking

Thomas Bierhoff
Atos Germany, Head of Technology

Multi-sided, cloud-based business platforms have demonstrated their power and economic value in the past decade, most prominently represented by success stories like Amazon Marketplace. It turns out that brokering of offerings and demands on a highly automated digital platform provides even more revenues than selling services and products.

Collaboratively addressing the dilemma of parking in a smart city through a multi-sided business platform is the next step for cities and their stakeholders.

Pressures on drivers and the environment

While public transport is often pushed by city authorities to reduce traffic volumes and make the trans-modal shift work, the growing volume of individual traffic is still challenging — especially during rush hours. These challenges are exacerbated by the limited amount of parking sites. Drivers look for parking near their destination, but if they are unable to find a suitable place immediately, they are forced to continue driving until they find a parking site by chance. These driving odysseys produce significant pressure on traffic, generate additional air pollution and emission and put stress on drivers.

There are many research studies available about traffic volume and its impact on cities. One such study is the 2017 INRIX study, which investigated the impact of parking site gaps in German cities on inner city traffic congestion. These investigations have uncovered the fact that the lack of parking sites in inner cities is a major cause for traffic congestion. The study analyzed the traffic problem from an environmental, monetary and time perspective and included multiple stakeholder views. Some key facts and figures of the study are listed here to illustrate the importance of smart parking solutions for keeping traffic manageable.

Timewise, key facts and parameters mainly focused on the amount of time drivers spend searching for parking sites inside the ten largest cities in Germany. On average, drivers spend 41 hours per year searching for open parking spots in inner cities. This time is not only unproductive, but also very stressful for drivers, especially when they are under time pressure.

Mobility

The environmental aspects focused on greenhouse gas emission, considering a mix of diesel and petrol driven combustion engines. The study used a moderate fuel consumption of 8 liters/100 km for petrol and 5.5 liters/100 km for diesel cars for inner city traffic. Assuming a greenhouse gas emission factor of 23.8 for petrol cars and 26.5 for diesel cars, the overall greenhouse gas emission amounts to a tremendous 2.3 kg per year per driver. Even without accounting for other air pollution (such as fine dust, hydrocarbons and sulfur dioxide), this figure clearly shows that parking challenges put strong stress on environmental conditions.

Holistic approach for multiple stakeholders

Parking is a multi-dimensional challenge in cities for a multitude of stakeholders, including but not limited to, individual drivers, logistics and delivery service companies, local shops and stores, local companies, city residents, private parking providers, law enforcement and city administrations. In general, these stakeholders can be subclassified into those who search for parking opportunities and those who provide parking opportunities. In order to holistically capture the parking problem and its impact, the needs and requirements of the stakeholders on both sides must be considered.

Solutions to improve public parking require a holistic approach which unifies the existing types of proprietary public parking systems and sensors to gain an overall view of the current and anticipated parking situation inside the city. Moreover, it must provide an open architecture with a high degree of adaptability to emerging parking technologies to ensure technological sustainability and future-proofing. As a third challenge, it must also offer a multitude of digital capabilities to serve the needs of various stakeholders in a trusted and secure solution. Meeting this last requirement depends on system reliability and data privacy, handling monetized processes with care by trusted organizations.

Integrated system-of-systems

In general, this overarching solution must master a "system-of-systems" and integrate a large variety of proprietary parking systems, parking sensor systems and their related information and communication systems. The primary challenge is the integration of existing parking systems without the ability to adapt them — as they are often not standardized or interoperable, or simply do not provide any digital interface for system integration purposes.

Another challenge is the vast amount of heterogeneous system devices and sensor technologies in the field, which require unified device management for monitoring proper operation and providing fraud detection. This is a technological challenge due to both the use of proprietary devices and communication technology, and the high number of devices in the field. With the emergence of the Internet of Things (IoT), these will only increase as IoT technology enables highly distributed but interconnected parking sensor systems.

Smart public parking platform

The open solution concept of an Cognitive Data Platform will enable cities to address the public parking management challenge on a city-wide level and target the integration of existing parking systems to gain digital transparency about the current parking condition inside the city. Based on this real-time transparency, several digital services can be offered to meet stakeholder needs.

Thus, what is required is an overarching "Smart Public Parking Platform" which represents a system-of-systems that puts single, trusted responsibility in the hands of the smart city

traffic administration. Stakeholders such as parking providers can decide to what degree they will participate, and to what extent they will outsource their parking services and business operations.

The Cognitive Data Platform will provide the basis for a multi-sided smart parking platform that serves stakeholders who are searching for parking opportunities as well as those who provide the parking sites. It will enable a virtual marketplace to bring both kinds of stakeholders together effectively for holistic public parking management at a city level. With this market platform in place, smart cities will become more attractive for their citizens and visitors.

9.3 Mobility is getting public and personal

Kulveer Ranger
Atos Senior Vice President, Strategy & Communications, Atos UK&I
Former Transport Advisor to the Mayor of London (2008-12)

The history of transport is integral to human evolution. From the invention of the wheel to the development of railways and the creation of the internal combustion engine, our ability to move has shaped our society and the world we live in. The next evolution will be fueled by data and centered on us.

Increasingly, with population growth and denser metropolitan conurbations, we see the need to support the mass movement of people and goods with efficient, effective and integrated multi-modal public and personal transport systems.

Transport operators all over the world are beginning to rely heavily on data — harvested both from within their own networks and systems and from the personal mobile devices of individuals.

A key game-changer in making this type of travel data available was the implementation of smartcard technology, such as the Oyster card in London and the Octopus card in Hong Kong. For the first time, multi-modal journeys could be integrated seamlessly for individual commuters. After the Oyster card was launched in 2003, it delivered huge value not only in the form of revenue protection — the entire network became a gated system by which access in and out could be recorded and charged — but also through the

availability and analysis of vast amounts of data in order to model, predict and more effectively manage the transport network.

Transport operators have sought to progress and develop the value of these types of smartcard platforms by gradually integrating different systems to attain an ever-broader view operationally, while also tracking and gaining a greater understanding of individual movements.

The ever-evolving use of personal digital technology has also made "personal mobility" easier to use and track. It is why we have witnessed the massive expansion of platforms such as mytaxi and Uber, car and bike-sharing apps, and journey-planning platforms like Waze that correlate multiple live datasets. This more flexible and richer personal mobility mix has disrupted the industry, coupled with changes to journey and work patterns.

However we choose to travel, what we used to think of as a "map" is now a real-time journey advisor, our journey's friend, providing hints, tips and nudges along our route. It also layers other relevant information: the location of your nearest favorite coffee shop, services that might be of interest or "relevant" offers we might like to take advantage of as we go. When we do get into our cars, we can forget the basic satellite navigation that used to lead us down a dead-end because the data was out of date. We live in a world where IoT-enabled vehicles not only know the route we should take, but also the speed we should travel, how to avoid the traffic as we go and even the weather we will encounter.

So where is all this information taking us?

With the myriad of personal mobility services and platforms being developed, what we should now expect is consolidation and increasing personalization of services. In the past, transport authorities would have been the focal point for integration. Today, it could just as likely be an intelligent "go compare"-type personal mobility aggregator. With mobility information integrated, we will be able to access real-time options through our own personal mobility dashboard, showing taxis, bike hire, car share, rail and bus journeys, etc.

All of this is organized with us at the center and taking into account our preferences and variables: price, traffic, weather, CO2 produced by the journey, the best discounts available on certain routes, events, diversions, road construction and of course, our favorite mode of transport.

To realize this vision of personal mobility, vast amounts of data from different apps and services will need to be aggregated. This will be a huge technological feat for innovative integrators and digital architects. Given the volumes involved, it will not be efficient or even practical to draw together data from every location into single points. We are entering the age of edge computing, when data will live where it is created: on individual devices, at the so-called "edge" of the digital ecosystem. Effort and creativity will also be needed to achieve the necessary cultural and behavioral changes; citizens will need to buy into the value of using an aggregator, feel confident in the services and be nudged into adoption, potentially using gamification and incentivization.

While there are clearly many challenges, with imagination, innovation and increasing collaboration, they are entirely surmountable. Historically, the transport industry has always been visionary in leading the adoption of new technology. Motor cars, high-speed

trains, jet planes and underground metros have all enabled and enhanced the world we live in, but this next transport evolution will be centered on the individual.

Mobility

The direction of travel will now be driven by the power of data, digital platforms and aggregation — creating efficiency, speed and exciting sustainable options for us to choose from, while making our personal mobility simpler and easier than ever before.

9.4 Making connected mobility a reality

Luc Pierson, Red Hat Principal Solution Architect

Increasingly, the Internet of Things (IoT) is enabling local authorities and mobility providers to extract and use great volumes of data from fixed and mobile sensors.

As these technologies evolve, the centralized platforms that deliver them should be robust, secure and easier to use. They also should be scalable (vital for any IoT solution) and interoperable (so that data can more easily be collected from all kinds of places).

Atos's Vertical Competence Center for Public Platforms has developed a standardized IoT platform to address these challenges. The public platform is available on demand and is based on a managed service developed in collaboration with technology partner Red Hat. It is designed to collect and aggregate data from fixed and mobile devices that are tracked and mapped in real time. The systems, devices and sensors that collect this data can be on trains, buses, trams, cars and fixed infrastructure, and can also gather information about the objects and environments around them.

The platform is designed to analyze and visualize data for those involved in planning and managing mobility services through a set of dashboards and serves information to the consumers of those services via a mobile app.

Current applications

Atos's Innovation Lab is working for the French Ecological Ministry in Bordeaux to deliver a road information management solution for cities. The solution employs new vehicle-to-vehicle (V2V) and vehicle- to-infrastructure (V2I) ITS communication technology and provides powerful analytics dashboards to aid real-time decision-making by city planners. While Atos's smart city platform collects many different sets of data, the real value comes from looking at where datasets intersect — for example, measuring the impact on air quality of different planning decisions such as closing streets or adding extra buses. Over time, the city can identify trends to inform future planning decisions.

The Atos team is also working with the R&D Institute VEDECOM in Versailles and local government to develop the platform to improve mobility services in Versailles by giving residents and visitors real-time information about cab sharing, carpooling and even the use of integrated autonomous vehicles. The platform aggregates open data so citizens can see a live dashboard to help them make better informed transport choices in real time.

Out of the box

The value of the platform to transport planners and operators is that it can be deployed quickly and securely. It is a ready-to-use, flexible, fully managed service. This means that instead of having to focus on developing or maintaining advanced technologies, transport planners and operators can focus on using the data to plan and create new services.

The platform is designed to comply with European IoT standards and data regulations and can be used by any city.

10 Open source

10.1 Open source and open standards

Ulrich Ahle, CEO FIWARE Foundation

FIWARE brings a curated framework of open source platform components which can be assembled together and with other third-party platform components to build smart solutions faster, easier and cheaper. A simple yet powerful API (FIWARE NGSI) enables the integration of components and provides the basis for the interoperability and replication (portability) of smart solutions.

Becoming truly smart

Our reference architecture for smart cities breaks vertical silos, building a context information management layer that provides a holistic picture of what is going on in the city. By making city data public and merging data from multiple verticals, city-level governance systems can be enhanced.

Common information models

Due to "de-facto" standard information models, there are no costs of adaptation to achieve full interoperability among many different systems in the city. This, in turn, enables the portability of systems across sectors and cities.

Unleashing right-time open data

Third-party solution providers can benefit from right-time open data published by the city and made available through standard APIs. They can sell their solutions to cities across the world, targeting a larger market and boosting businesses.

Thriving data economy

Once the data gathered from all sources are made public and exchangeable, city administrators can offer higher value services to citizens, as well as improve public service delivery. This creates an innovative scenario that cities, private business, and citizens can all benefit from.

11   Why Atos?

Cities need a single Cognitive Data Platform to deliver smart integrated services to their citizens, visitors and economic partners. A single Cognitive Data Platform provides security and data privacy rules on data capture, storage and access. It is the backbone of a truly data-driven city and the enabler of a robust data economy.
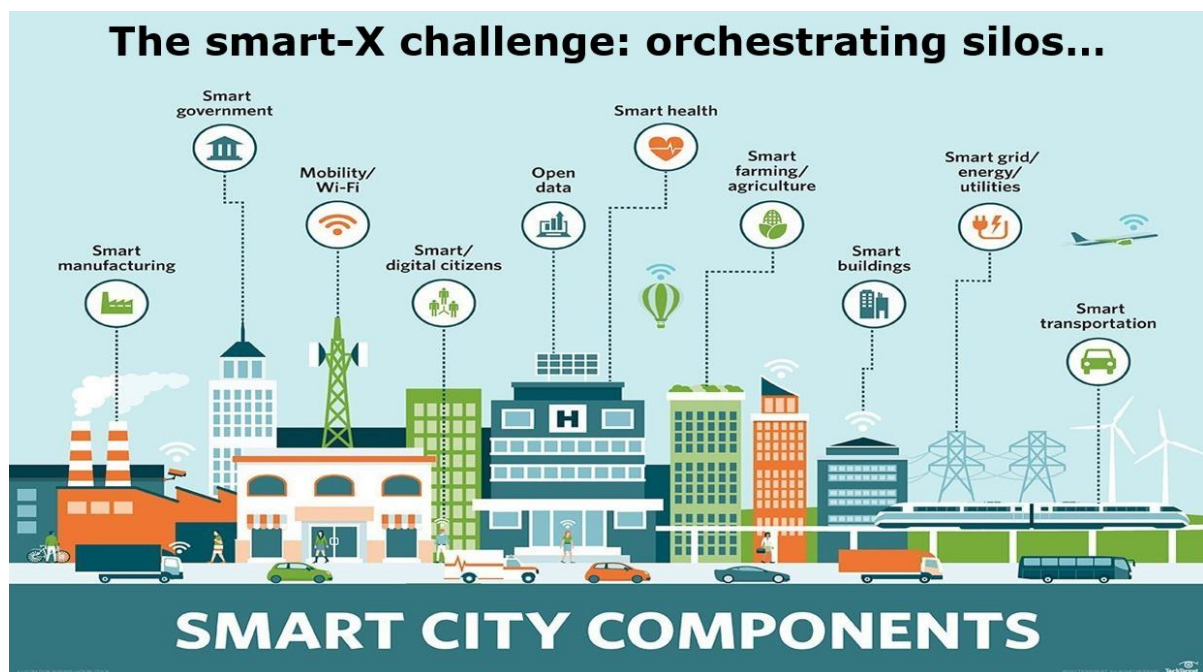
The Cognitive Data Platform approach means that end users — citizens — are served with information on a large range of topics; it is important to put citizens at the heart of service design.

Whether it is safety, mobility or utilities, effective public data management is based on **trust**. Trust must come from the design of the systems-of-systems approach, fully secured with respect to privacy. In creating use cases for smart cities, Atos follows a strict privacy by design approach and brings deep knowledge of creating a trusted Cognitive Data Platform.

As a global systems integrator, we have been ranked by analysts as a leader in many of the domains involved in creating a smart city. Working with cities around the world on the topics of trust and open standards, we were invited to be the first corporate member of the Open Agile Smart Cities Community.
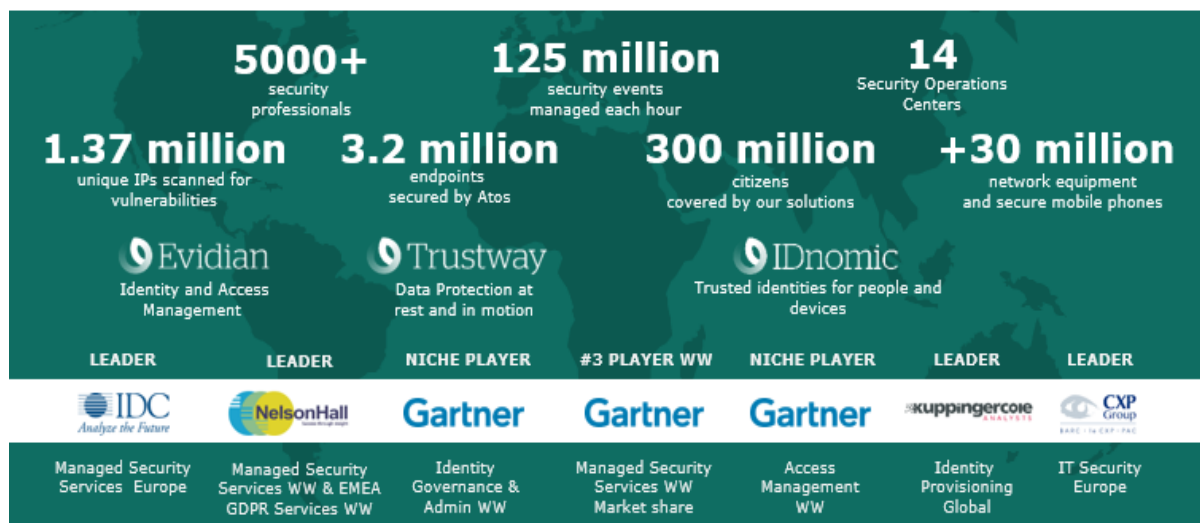
Atos was ranked a leader in the 2020 *IDC MarketScape for European Professional Services for Smart Cities* vendor assessment. As a recognized leader in the cybersecurity industry, Atos helps cities embrace trusted Cognitive Data Platforms.

In its *Enterprise Edge Compute Market Landscape,* TBR recognized Atos for our unique value proposition in the edge computing market, with a services-centric positioning and foundational hardware offering.

Why Atos?

On data access security, Atos provides a unique range of knowledge and solutions, including IDnomic for secure IoT and data access based on multi-factor authentication. The infrastructure components we developed for the growing IoT and data-driven services market come with multi-factor authentication security access.


Recognized leader in the security industry

Atos was ranked a leader in the June 2020 TBR *Market Landscape for Quantum Computing*. High performance computing is a foundational technology required for near real-time response systems in a smart city.

In a system-of-systems approach, it is important to have open standards for connection systems and devices. To achieve this goal, Atos is an active member of standardization committees, including as a platinum member and founding partner of the FIWARE Foundation — where we contribute to open source solutions for Cognitive Data Platforms.

Atos has a center of excellence that supports smart city engagements on a global scale. Our platform research and development is done by a central team at our Innovation Lab in Bordeaux. As a global player, our support for delivery and partner engagement around the world ensures that we maximize the benefits we pass on to our clients. Working with Atos will position any city in a global network of Atos customers.
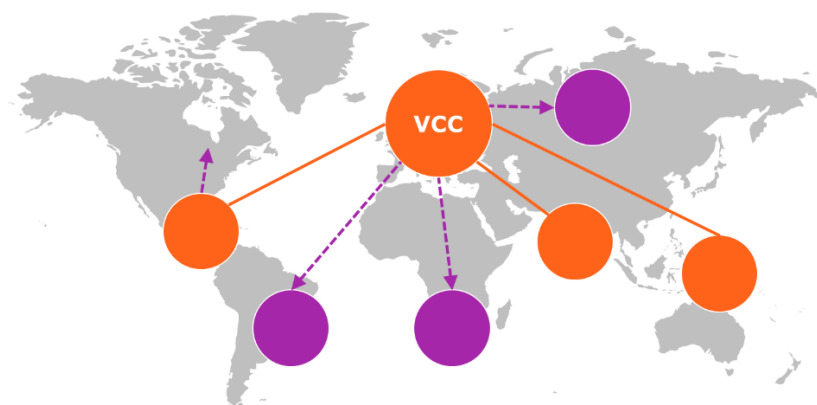
Why Atos?

The awards Atos has received for smart city projects include:

2004 – Atos consultative approach to smart city planning was accepted by British Standards Institute under PD181.

2006 – Innovation award on CityPulse project, for creating non-privacy intrusive video surveillance.

2008 – Award for best ecosystem player in smart cities, leveraging the power of start-ups and collaboration with different stakeholders.

2020 – Award for innovation in public safety using a digital twin approach as member of a global consortium.

2020 – Awarded as a platform provider for smart city Hilversum in an open partner ecosystem.

12 Expert gallery

Atos	
Albert Seubers Atos Director, Global Strategy Smart X	*Bruno Morel* Project Manager, Atos Worldgrid
Franck Freycenon Atos Worldgrid	*Clara Pezuela* FIWARE Foundation Technical Steering, Committee, Atos Research Innovation – Innovation Lead
Sylvie Le Guyader-Colliot Atos Director, Digital Platforms; Public Sector & Defense Industry	*Tomasz Grodecki* Atos Poland Consulting Manager
Thomas Bierhoff Atos Germany, Head of Technology	*Kulveer Ranger* Atos Senior Vice President, Strategy & Communications, Atos UK&I; Former Transport Advisor to the Mayor of London (2008-12)
Eric Monchalin Atos Vice President, Head of Machine Intelligence	*Iratxe Gomez* Atos Expert in Public Safety

Expert gallery

Partners

Ulrich Ahle

CEO, FIWARE Foundation

Fredrik Beckman

Marketing Manager, SENSATIVE AB

Egbert Jaspers

CEO, ViNotion

Luc Pierson

Principal Solution Architect, Red Hat

13   About Atos

Atos is a global leader in digital transformation with 105,000 employees and annual revenue of over € 11 billion. European number one in cybersecurity, cloud and high performance computing, the Group provides tailored end-to-end solutions for all industries in 71 countries. A pioneer in decarbonization services and products, Atos is committed to a secure and decarbonized digital for its clients. Atos operates under the brands Atos and Atos|Syntel. Atos is a SE (Societas Europaea), listed on the Next 20 Paris stock index.

The purpose of Atos is to help design the future of the information space. Its expertise and services support the development of knowledge, education and research in a multicultural approach and contribute to the development of scientific and technological excellence. Across the world, the Group enables its customers and employees, and members of societies at large to live, work and develop sustainably, in a safe and secure information space.

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