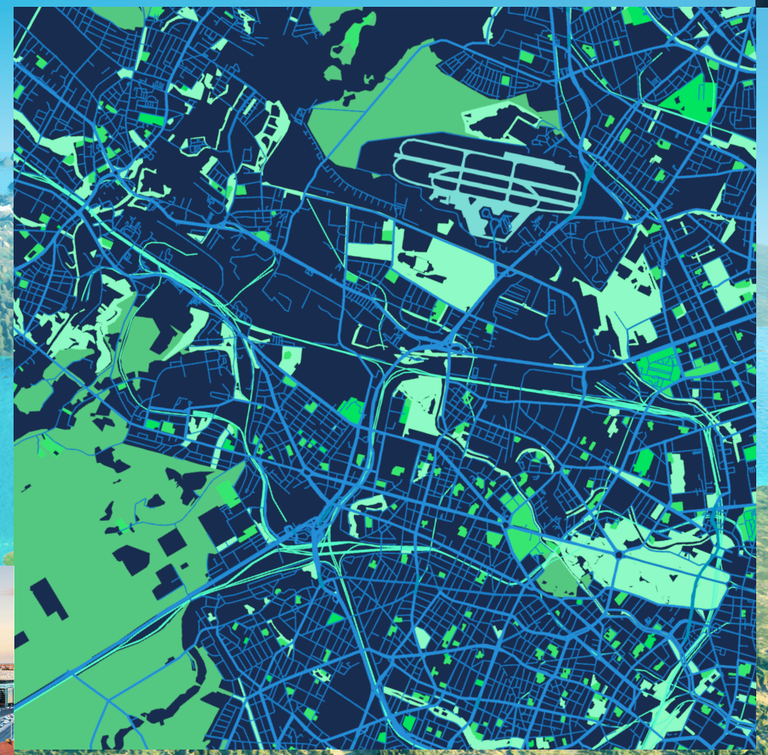
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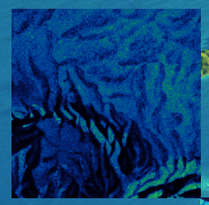
LOCATION INTELLIGENCE

Insights That Transform Decision-Making

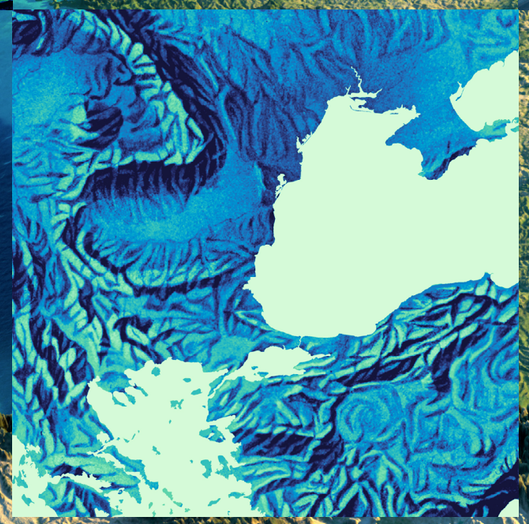








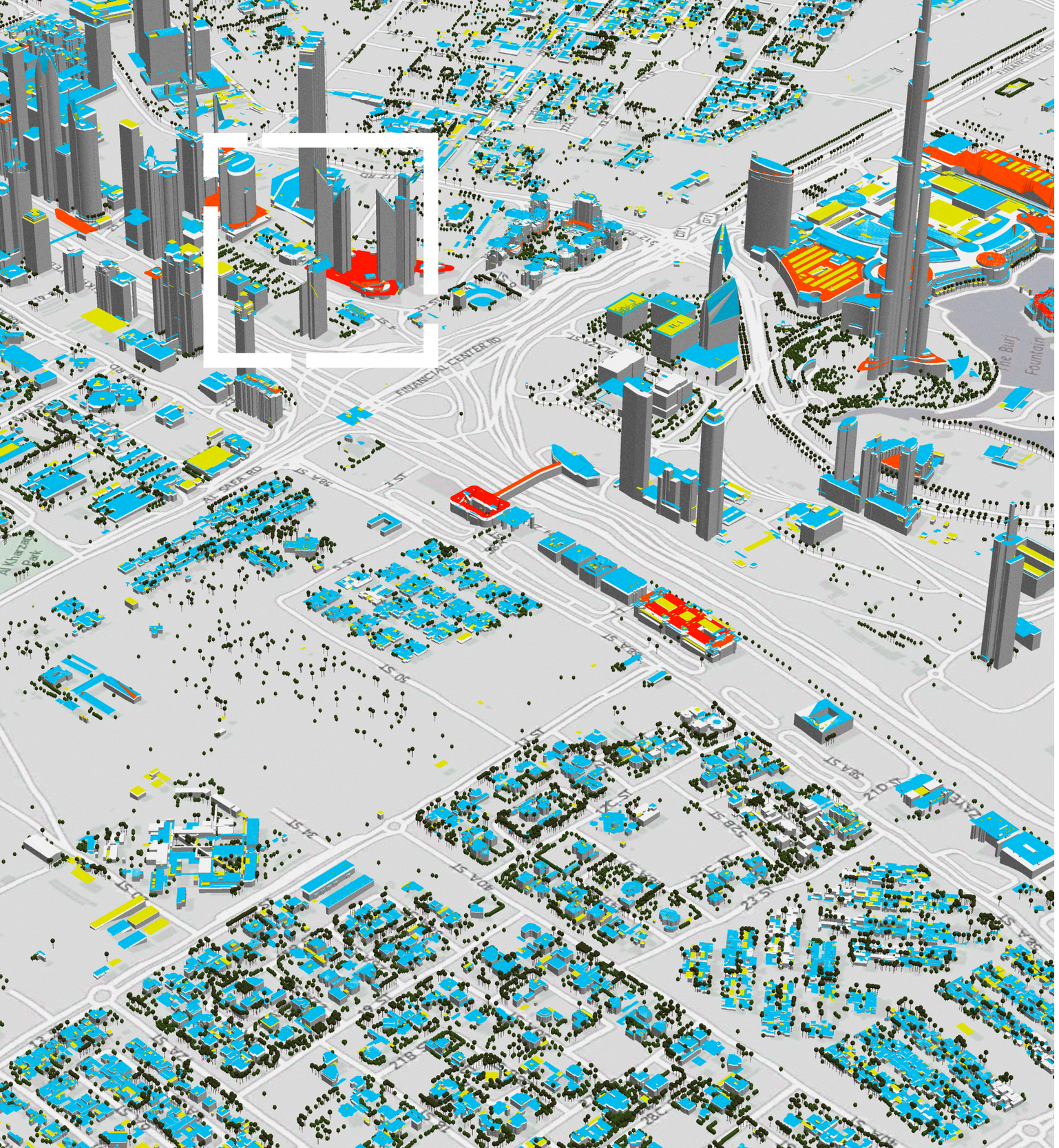












LOCATION INFORMATION HAS ALWAYS BEEN IMPORTANT. NOW WITH BILLIONS OF SENSORS AND SMART DEVICES, WE HAVE MUCH MORE OF IT. AS THE VOLUME AND DIVERSITY OF DATA EXPANDS, SO DOES THE NEED TO VISUALISE AND ANALYSE IT.



LOCATION INTELLIGENCE

Seeing Opportunities for Business Growth in a Deeply Connected World

For decades, many business leaders have understood location to be foundational for operations and growth. In recent years, the importance of *where* has grown exponentially. The reason is simple. As the volume and speed of data become greater, the location component becomes more and more vital to maximising data's value.

There may be no clearer example of the power and the importance of location intelligence than the COVID-19 pandemic. With iconic map-based dashboards, the pandemic showed that geography—location—is *the* framework we need to make sense of the complicated world we've created. Further, the pandemic underscored the importance of geography to core business functions like supply chain and risk management. Location adds crucial context. It enriches all types of data and helps tell the story of what's happening and why.

Location intelligence refers to insights gained from visualising and analysing data in terms of its geographic location—on a map or dashboard. Organisations generate location intelligence by using spatial analytics to detect and quantify problems on an enterprise level, make predictions, model solutions, and strengthen their business operations. Organisations can then answer a question that has enormous value: Why do things happen where they do?

Geographic information system (GIS) technology gives data a physical presence on maps, allowing organisations to add layers of relevant information to derive more meaning—like layering demographics, traffic, environment, economics, and weather to see trends and patterns of change. This is a powerful way to organise information from disparate sources. ▸



LOCATION INTELLIGENCE, WHEN DEPLOYED ON AN ENTERPRISE LEVEL, EMPOWERS AN ORGANIZATION TO DRAW CONCLUSIONS, MAKE CONNECTIONS, AND SEARCH FOR HIDDEN TRUTHS.

A common estimate of the amount of data in the world with a location component is 80 percent. That's why geography provides a powerful way of bringing all that data together to understand relationships and impacts.

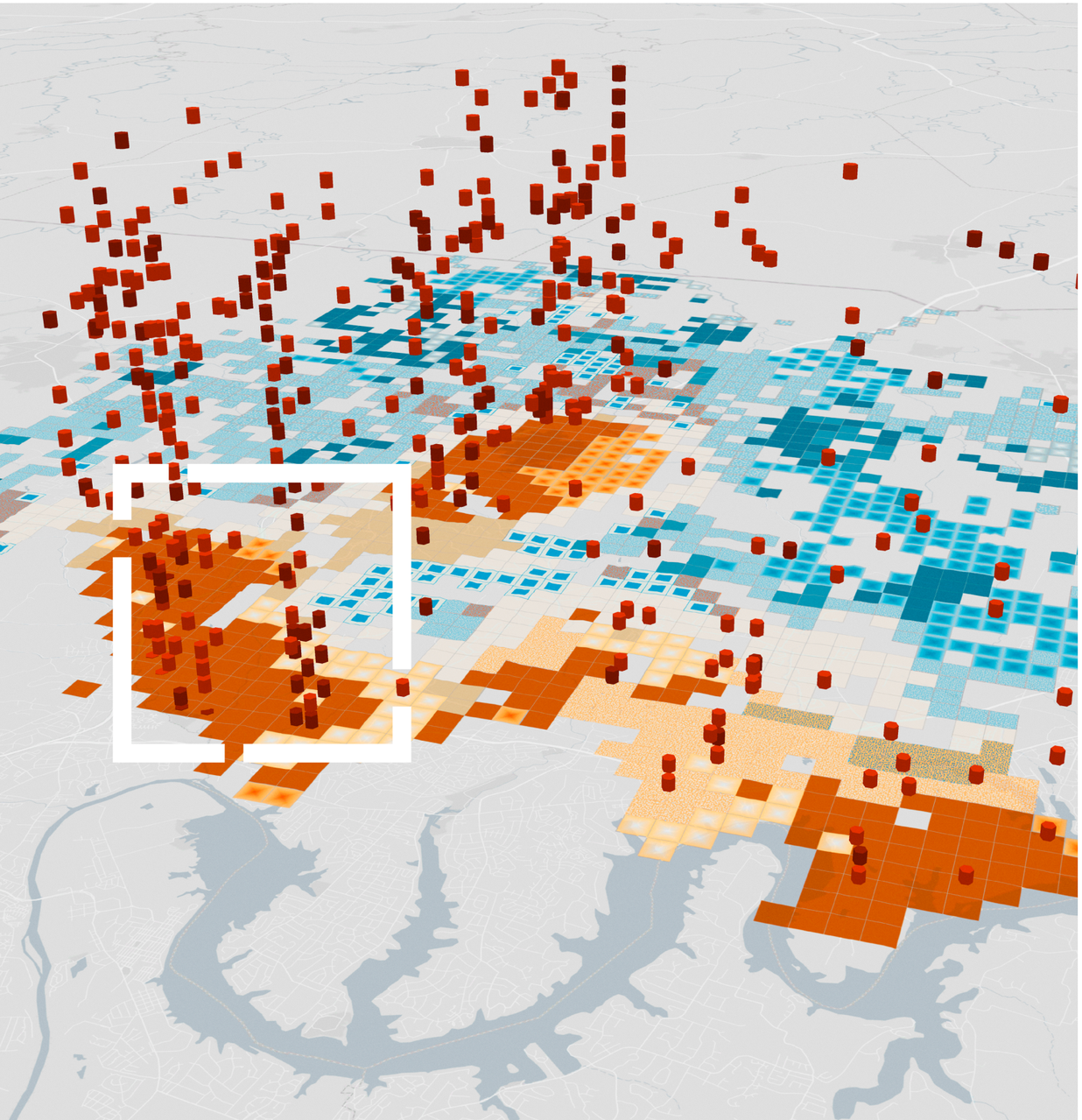
Location intelligence offers more than a way to think about data. It provides a way to organise, rearrange, and examine data from all angles to find the connections and hidden truths within.

If location intelligence is the objective, GIS is the most valuable tool to achieve it. GIS is what businesses looking for an advantage use to decide how best to move forward—determining, for instance, where to open a new store, how to manage assets, and how to mitigate risk and plan in an era of climate change. These are diverse problems, but they have two things in common: involvement with the question of *where*, and the need to process an enormous amount of data to find an optimal solution.

GIS was once solely the purview of geographers and mapping experts, but no more. User-friendly interfaces and cloud-based tools make location intelligence something that anyone can grasp and access. Information can be organised via the familiar visual vocabulary of maps. Dashboards allow for easy handling of data and gathering of statistical inferences from embedded maps. Enterprise-level GIS empowers organisations to share and collaborate with real-time maps, exponentially increasing the possibility of useful insights.

GIS is used to build billions of sophisticated maps and models, combining big data, artificial intelligence, and an ecosystem of apps to bring a location-based approach to the world's thorniest problems. ▸

THE CONTRIBUTION OF LOCATION INTELLIGENCE TO FUNDAMENTAL BUSINESS OUTCOMES IS ONE REASON WHY IT WILL BE WORTH €36 BILLION BY 2028, MORE THAN TWICE THE VALUE IN 2021, AND IT'S GROWING AT A RATE OF 15.3 PERCENT PER YEAR.



The Business Value of Location Intelligence

It has often been asserted that data is the new gold, but that analogy falls short. There is no question that data is linked to information, information produces insights, and insights are what give an organisation an edge over competitors. But gold is rare, and data is everywhere.

With so much data, organisations need a way to quickly filter it for what they need. They need good data—the kind that provides value reliably. GIS is both a creator and a consumer of good data, with tools to store, process, analyse, and visualise data.

Although GIS is often described as a mapping tool, the technology does much more than make maps. GIS provides a way of seeing and facilitating the interconnectedness of our world's systems—both natural and human-made. In Portugal, GIS has provided the foundation for a unified approach to disaster relief. In the Netherlands, a GIS-based digital twin provides an ongoing picture of rail traffic and maintenance.

This is the essence of a geographic approach–the understanding that everything is related to everything else–and that is why it holds power for any organisation. GIS is about finding those connections and uncovering the location intelligence.

This geographic approach took a huge step into mainstream consciousness during the COVID-19 pandemic. The Johns Hopkins University COVID-19 Dashboard attracted billions of users because it provided an information lifeline. The maps and graphics displayed on the dashboard gave people around the world a way to see and understand the complex health crisis as it evolved in real time.

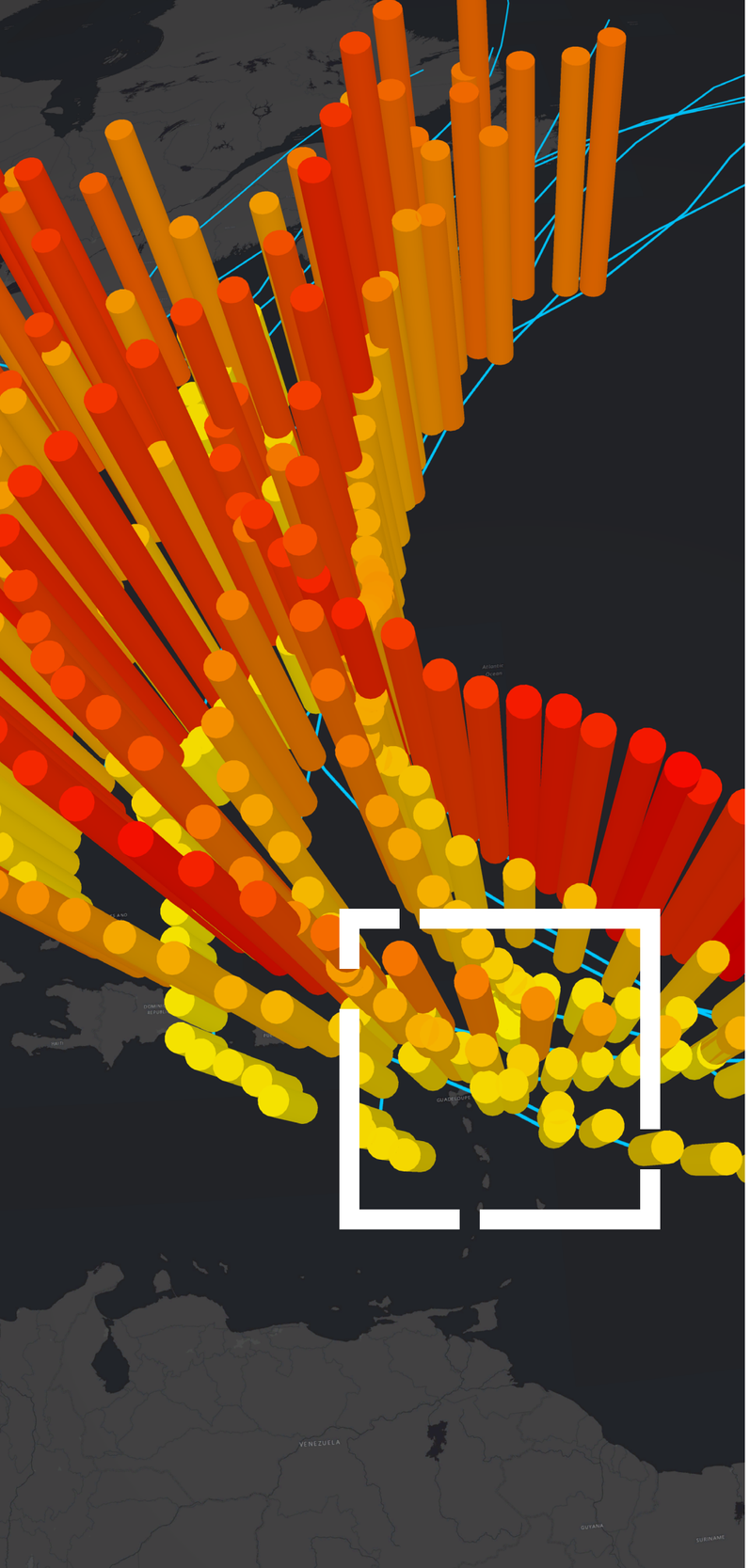
GIS has evolved to integrate other technologies, such as connecting financial, customer, and operational systems to unite the different types of data on a map. GIS also brings together building information models, CAD drawings, and reality-capture data to create dynamic digital twins that display spatial relationships. Geospatial artificial intelligence (GeoAI) brings together GIS and machine learning with algorithms that discern patterns and hot spots. ▸



The growth of the global geospatial analytics market is a testament to the essential nature of GIS for businesses. Between 2023 and 2027, the value of the market is expected to nearly double, reaching a value of US$153 billion.

C-suite executives across diverse sectors are reaching the same conclusions regarding the power of location intelligence. A recent survey conducted by Boston Consulting Group revealed a nearly universal respect for the value of location intelligence. In financial services, retail and e-commerce, logistics, real estate, and travel and tourism, nearly all respondents asserted that location intelligence is very or somewhat important to their business. Another survey, by Dresner Advisory Services, found that across companies, three enterprise areas—R&D, operations, and executive management—were most likely to recognise the importance of location intelligence.

The reasons for enthusiasm are easy to understand and not limited to market competitiveness. As the world grows more volatile and complex, challenges such as climate-related weather events, health crises, geopolitics, shifting regulatory regimes, the need for environmental management, and supply chain turmoil underscore the importance of geography and location intelligence. GIS delivers the contextual awareness leaders need to mitigate risks and achieve long-term sustainability as well as profitability. In simple terms, location intelligence pays huge dividends to understand—ahead of competitors—*where* things happen and *why*. ▸



The Many Applications of Location Intelligence

The applications of location intelligence are broad, especially when applied on an enterprise level and supported by real-time data. The former ensures that an entire organisation both contributes to and benefits from location intelligence. The latter ensures that decisions are based on the most current information.

Consider the advantages for **supply chain optimisation**, as businesses in the postpandemic world strive to maximise logistics and work around supply chain disruptions. A major US agricultural company can track the location of each truck, its temperature, and its trajectory, reducing costs due to spoilage. The same company can use location intelligence to understand why, for example, a particular batch of strawberries was superior. The company can see where that batch came from, right down to which part of the field. Staff can then analyse what was different about conditions in that location in order to repeat the success in the future.

The ability to **precisely track the origin** of every crop or commodity is taking on greater importance. Knowing which field, what farming practices, and the progress of the crop helps the timing of the supply chain. It also allows the company to be proactive if issues arise. For forestry products that may harm rain forests, certified sustainability practices and material source knowledge have become a business imperative, supplied by location intelligence.

Consider the prevalence of extreme weather events, which will continue to worsen as climate change intensifies. A large weather event can ripple into enormous impact on local residents, international supply chains, and retailers. With location intelligence, organisations can **proactively approach a major climate event** by using analysis to mitigate damages and make strategic decisions. In Prague, GIS helps planners understand how climate change affects the city, and take the necessary mitigation steps.

Imagine a logistics company with a cargo ship scheduled to pass through the Suez Canal just before a storm is predicted to make landfall. Analysis of real-time data feeding into GIS empowers company leaders to react strategically and nimbly. By accounting for information from many data layers at once, they can make quick decisions to minimize supply chain impact.

Location intelligence allows government and disaster relief agencies to prepare for the same storm and respond efficiently after it hits. By modeling and tracking storm surges and water flow with GIS, agencies can predict which areas will be hardest hit, informing evacuation plans and allowing predictive and reactive aid.

As wildfires grow in frequency and intensity, firefighters use GIS to visualise and study the movement of each blaze—communicating that information quickly to everyone involved. In the fire's aftermath, land management agencies look to GIS to determine best practices for replanting trees and restoring habitats.

Many organisations integrate location intelligence into their day-to-day business operations, particularly in the form of **location-aware digital twins**. In Australia, one of the largest energy companies built a digital twin that contains over 24 million features, from substations to the point of entry into the home. Field crews working in remote locations can search the digital twin for assets in the network, zoom in, access information, and trace the connectivity to the power source and the customer service point. ▸



The energy company is using its digital twin to deal with increasingly common floods and fires. Staff plot data from past events, show affected areas on a map, and then anticipate which assets will be endangered in the future. In this way, GIS models the past, present, and future to provide location intelligence through space and time.

A major work clothing manufacturer redefined its business to accommodate the changing habits of customers, using location analysis to **assess new markets and understand consumer behaviors** across channels. The manufacturer's location intelligence powered a road map to selling goods at brick-and-mortar stores and via wholesale distributors, retail partners, and e-commerce sites.

Premium coffee maker manufacturer Nespresso uses location intelligence for multiple business ventures, including a sustainable coffee growing program, reforestation, and aluminum recycling. With more than 75,000 farmers growing the company's coffee, and with customers around the world, Nespresso leaders recognise location intelligence as crucial to synthesising their overall growth strategy.

A truly location-intelligent organisation empowers everyone to **create**, **manage**, **and share location-based information**. Mobile utility crews, for example, can use a smartphone or a tablet to securely send and receive inspection and maintenance updates between the field and the office. Managers can monitor the progress of their personnel. Customer service agents can see what's going on in real time to provide customers with information about outages and repairs. Executives and accountants can visualise and analyse the entire system before deciding where to prioritise infrastructure funds. ▸

BUILDING DATA SCIENCE CAPABILITIES AROUND LOCATION INTELLIGENCE HELPS BUSINESSES SEE THINGS FROM A DIFFERENT PERSPECTIVE, TO THINK ABOUT THE JOURNEYS OF PRODUCTS AND CUSTOMERS THROUGH DATA.

The Geography of Data Science

These examples of a geographic approach to problem-solving only scratch the surface of what location intelligence offers organisations across retail, manufacturing, supply chains, utilities, insurance, telecommunications, banking and financial services, government, and logistics.

Increasingly, location is the key to unlocking hidden and valuable insights within data—to make decisions that improve customer experiences, create operational efficiencies, and increase productivity. Seeing relationships between and among data points and translating those relationships into actionable information are critical to maximising the value of the data pouring in. ■



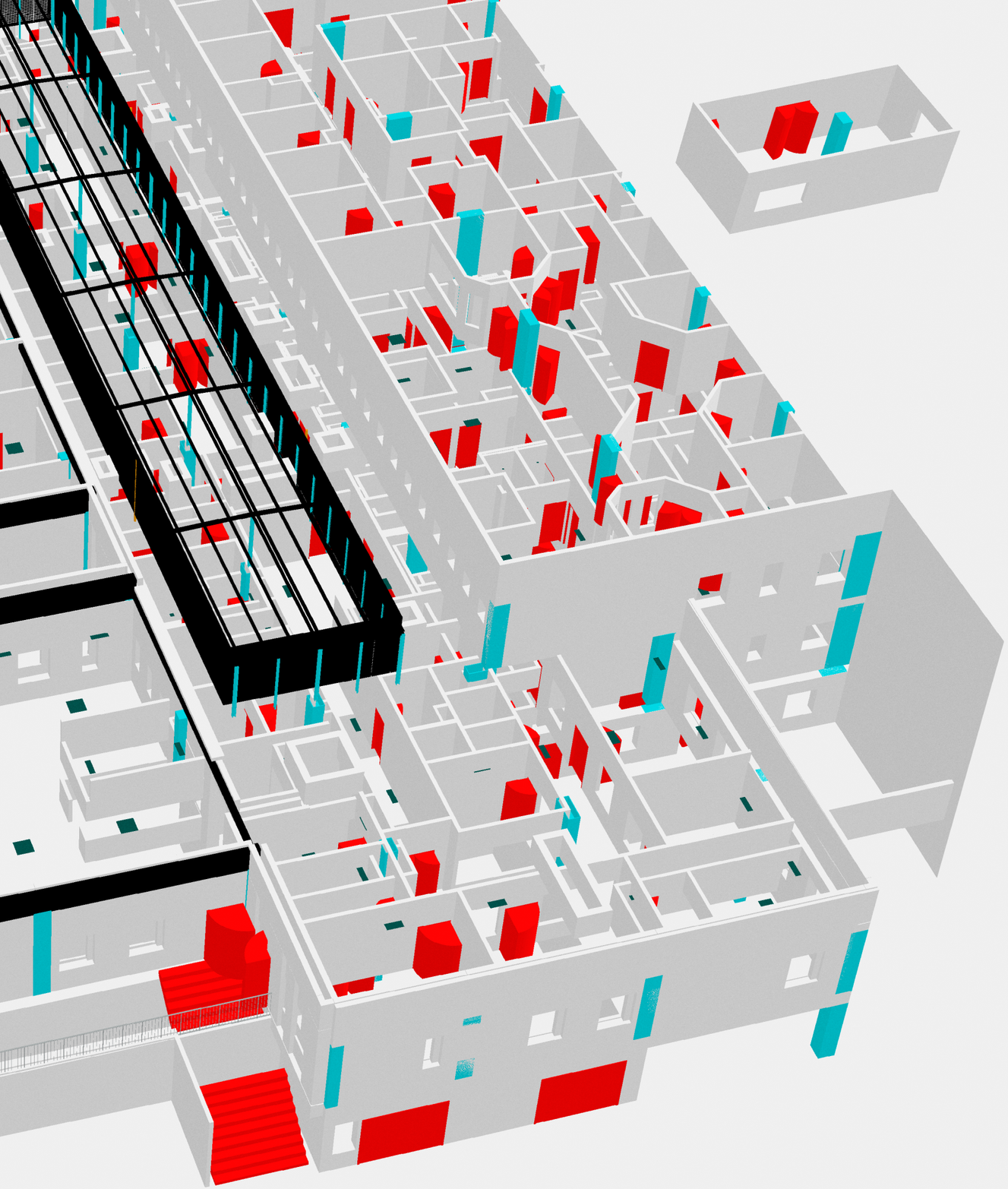
LOCATION INTELLIGENCE MOVES INDOORS

Apple

It's estimated that most Americans spends 87 percent of their life indoors. While our trusted GPS-equipped mobile devices help us navigate almost anywhere outside, they lose accuracy once we go indoors.

Indoor mapping, or the lack thereof, is often a challenge for people who need to move around a facility like a hospital, convention center, industrial plant, corporate or university campus, or airport. There is a growing demand for maps that show a person's location in relation to the inside of a building, helping them locate, for example, an available conference room or a high-pressure valve that needs immediate inspection.

To have truly effective location intelligence, an organisation needs more than an indoor map. People need indoor positioning to see their current location—that "you are here" blue dot—in the context of nearby people, spaces, and assets. ▸

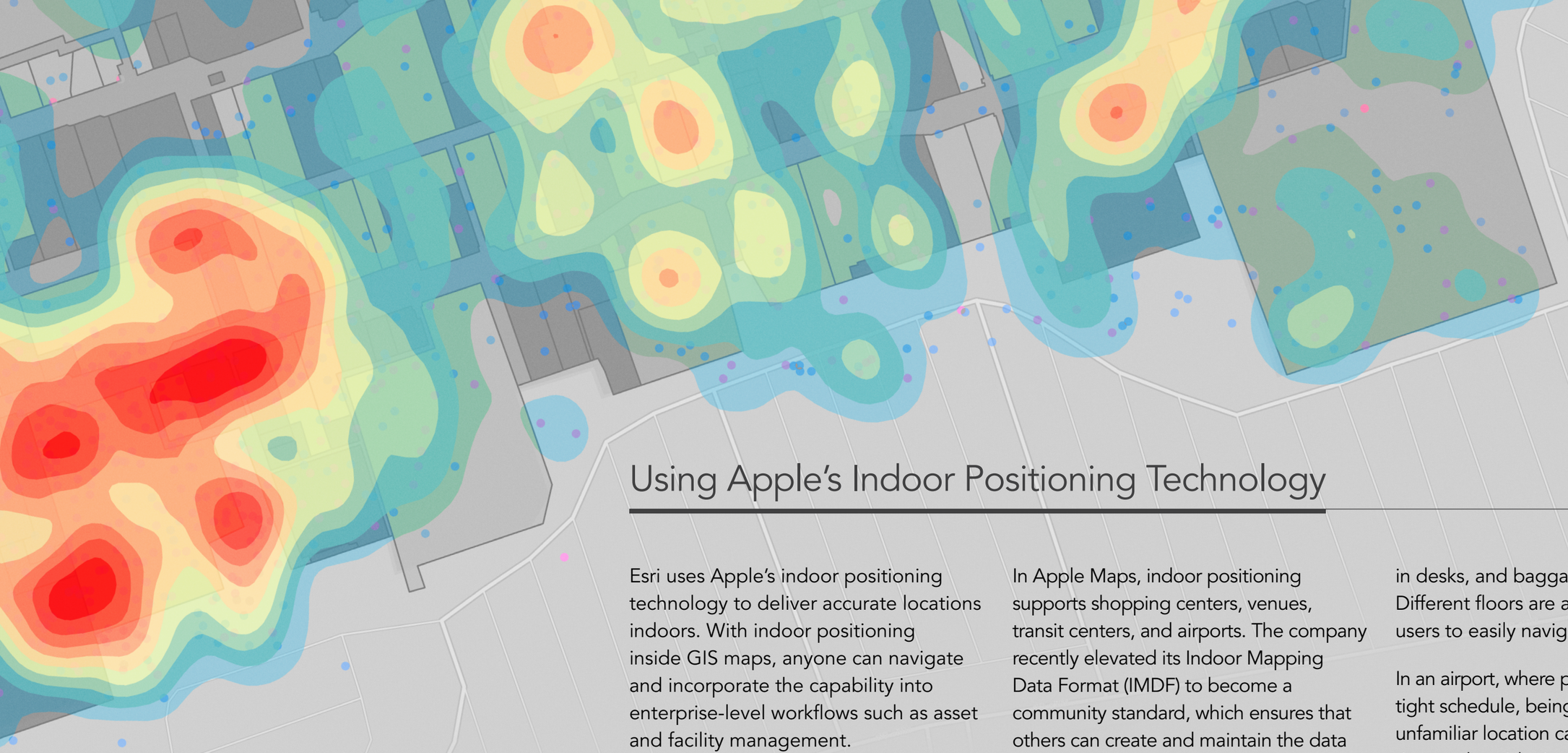


Bringing the Power of Location Inside

Indoor positioning gives employees, customers, travelers, and visitors the ability to see and share their locations in relation to important assets, rooms, departure gates, and offices. This information, combined with navigation, scheduling, and analytics, helps people inside buildings operate at an increased level of efficiency and safety. Using location intelligence tools, indoor positioning enables businesses and organisations to better coordinate spaces and other resources.

From simple mobile apps to complete enterprise systems, indoor positioning adds a new dimension to the application of location intelligence technology.

Managers and executives can take advantage of indoor positioning by accessing interactive dashboards that stream data from sensors inside a facility. Meanwhile, visitors and employees benefit from indoor positioning by being able to use their computer or smartphone to find information about the buildings they occupy. Building operators and occupants can access floor-aware 3D maps to find critical business information such as the location and status of fire extinguishers and their last inspection dates. Enterprise knowledge workers such as maintenance, IT, security, medical, and visitor management personnel are particularly well supported by the emergence of indoor mapping and analytics. ▸



Using Apple's Indoor Positioning Technology

Esri uses Apple's indoor positioning technology to deliver accurate locations indoors. With indoor positioning inside GIS maps, anyone can navigate and incorporate the capability into enterprise-level workflows such as asset and facility management.

With the crucial positioning element developed by Apple, apps with indoor maps and location deliver advances for large venues. In many cases, Wi-Fi location services meet the positioning requirements of an organisation without the need to invest in Bluetooth beacons. Maps display both indoor position and floor level, determined using a combination of information coming from the sensors on the iOS device together with information from Wi-Fi signals in the building.

In Apple Maps, indoor positioning supports shopping centers, venues, transit centers, and airports. The company recently elevated its Indoor Mapping Data Format (IMDF) to become a community standard, which ensures that others can create and maintain the data so that indoor maps will proliferate. Apple has also considered the rise of robots. Its IMDF provides machine logic to help intelligent machines make accurate navigation decisions in real time.

The company's pioneering work in indoor positioning is providing visitors and staff with a full layout of each airport or mall. It uses an interactive map to show the location of features such as restaurants, shops, bathrooms, gates, terminals, security checkpoints, check-in desks, and baggage claim areas. Different floors are also marked, allowing users to easily navigate.

In an airport, where people are often on a tight schedule, being able to visualise an unfamiliar location can help travelers save time and avoid missed flights. In the case of a large and complex mall, stores can be filtered by category—clothes, beauty, or food, for example—enabling people to more quickly find what they are looking for.

Many private organisations such as hospitals, universities, and corporate campuses are using IMDF to create and maintain their own maps—because employees and visitors alike benefit from an accurate and up-to-date facility map. ▸



Putting Buildings on the Map

GIS technology from Esri can create and consume Apple's IMDF. Esri leverages Apple's indoor positioning capabilities to bring location intelligence to enterprise organisations and knowledge workers everywhere. The ability to deliver situational and contextual awareness through indoor maps was important during the physical distancing phase of the pandemic. As working from home has transitioned into hybrid work environments, companies have cut back on physical space to reduce cost and maintenance. The concept of hoteling, with adaptable physical space assigned as needed, requires flexible indoor maps, especially on campuses that require coordination between a large group of employees and buildings.

Indoor mapping technology also helps organisations manage their facilities. Employees can see, for example, the precise location of malfunctioning equipment or be alerted to time-sensitive checks such as changing out filters. Using indoor maps, maintenance personnel know where to go and when to go there.

Security staff also benefit from indoor mapping. With real-time updates, the maps give them the ability to quickly ascertain any raised threat levels and quickly guide people away from danger if necessary.

Indoor navigation is particularly important for large and confusing places like hospitals. Technicians require accurate information about where people and movable assets are located at any given time—such as the proximity of patients to ventilators or expectant mothers to ultrasound machines. In a large medical center with an emergency room or an intensive care unit, finding resources quickly can be critical when seconds count.

The value of indoor mapping continues to compound, empowering managers of large facilities to draw authoritative conclusions about the status of operations, the flow of people, and the locations of resources. At the same time, the technology provides efficient navigation and more effective workflows for visitors and staff. ■



EVs and New Ways of Living

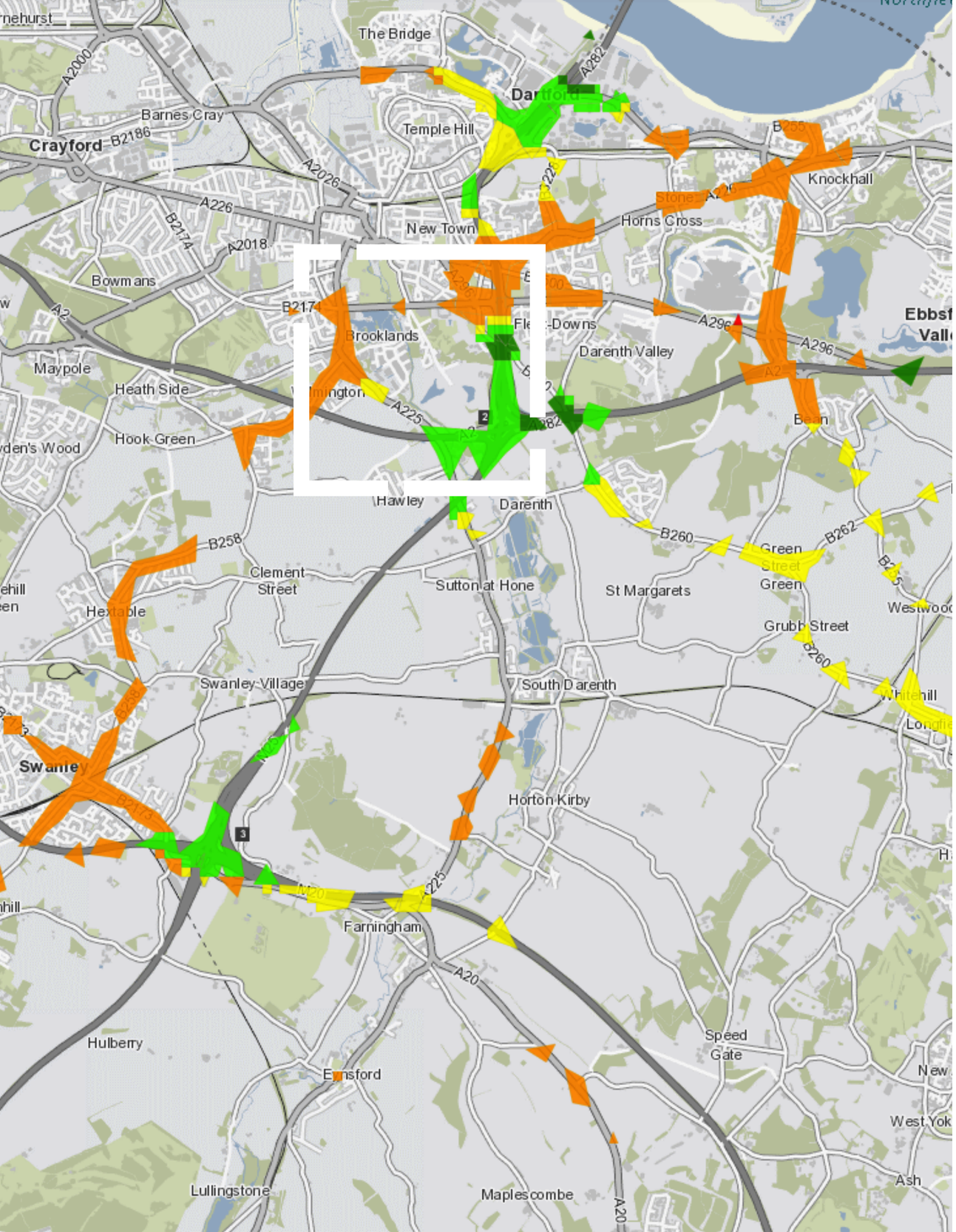
FUELED BY LOCATION INTELLIGENCE

The transition to the electric vehicle (EV) represents a long overdue response to the ongoing climate emergency. The European Parliament has pledged to cease sales of new fossil-fuel-burning cars by 2035, and automotive companies are increasing EV production.

The Infrastructure Investment and Jobs Act will invest US$5 billion to expand EV charging networks across the country. And the Inflation Reduction Act (IRA) lifts the per-manufacturer limit on the number of cars that can receive a plug-in electric vehicle tax credit. A rebate is offered even on used EVs to extend the benefit to all. Given that transportation is the greatest contributor to greenhouse gases, the combined investment and incentives put the United States within reach of its Paris Agreement commitment to cut emissions by half by 2030.

However, these changes also present new challenges. Mining lithium in sufficient quantities to withstand demand for EV batteries is itself carbon intensive and raises concerns over environmental degradation, resource extraction, and human rights. Additionally, EV charging infrastructure remains underdeveloped. Potential EV owners are reluctant to make purchases until charging station networks improve, while private investors that would finance EV infrastructure are waiting for EV production to catch up to demand.

These challenges require insights not only about where best to place new EV chargers but also in regard to broader urban plans and infrastructure practices. EV crossover represents a completely reimagined way for us to move and live. And the push to reduce dependence on fossil fuels is driving a transformation of our transportation infrastructure. Location intelligence provides the means to examine these complex issues and achieve clarity on viable solutions. ▸



Carter Jonas
Charging Ahead with the EV Transition

The EV era has arrived. As countries around the world are pledging to reduce emissions in the face of climate change, sales of electric vehicles are on the rise.

This trend presents perplexing infrastructure problems. In order for the transition to EVs to proceed at the pace needed to phase out fossil fuel-burning cars, charging station networks must grow.

The UK now has around 35,000 charging stations. For the country to meet its goal of zero emissions by 2050, it will need 350,000 charging stations, the same number that now exist in all of Europe. The continent as a whole will also need a tenfold increase as part of any net-zero strategy.

This represents an enormous economic opportunity. Increasing and improving charging networks should be a solid investment strategy.

But it's not that simple. Many potential investors are waiting for EV ownership to increase before committing to more and better charging networks. Many potential EV owners, meanwhile, are delaying making the switch, concerned about a lack of robust networks.

Carter Jonas, a London-based property consultancy, advises retailers and forecourt operators about whether they should install charging networks on their property. The company takes a data-driven approach, carefully examining everything from demographic information to technological considerations. Relevant variables include population settlement patterns, commute times, and whether a location is situated close enough to electrical grid nodes to make installation possible.

Doing thorough research is therefore a complex exercise in location intelligence. The huge amount and disparate varieties of data Carter Jonas must consider when advising clients can be overwhelming.

GIS provides a way to cut through this data glut. Visualising datasets as layers on a map shows how they interact to reveal where charging network installation would make the most sense now, where it might in the future, and where relevant infrastructure challenges are located. ▸



This geographic approach allows Carter Jonas to note patterns that would not otherwise reveal themselves in charts or graphs. Traffic data generated by Internet of Things (IoT) sensors provides a way to aggregate information on millions of car trips. A map layer displaying zoning regulations, combined with one showing where housing is likely to be built, helps gauge likely demand.

Commuting patterns and times add further context. Demographic information can suggest where likely EV buyers will live and work. Proximity to major highways can suggest whether a business will attract long-distance drivers worried about where they'll recharge.

All of these considerations can be weighed against infrastructure requirements. Will the details of the local electrical grid increase costs or even make installation not technologically feasible?

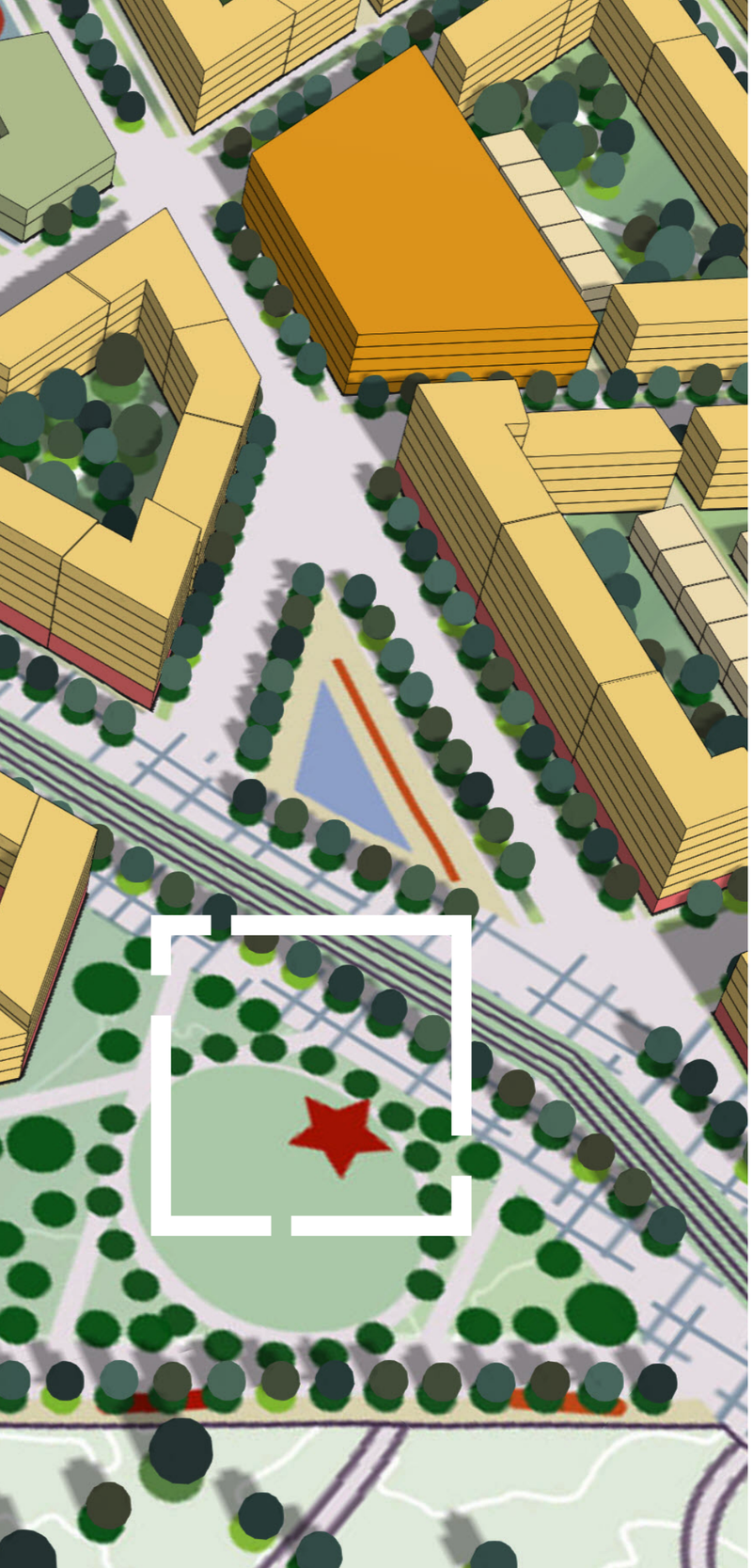
Carter Jonas can combine all the information of where EVs can possibly be located, and where they cannot, and generate maps of the best possible locations.

Maps provide clients with a contextual understanding of the situation in a way that written reports cannot. They also provide an easy way for Carter Jonas analysts to explain their methodology.

Carter Jonas's use of GIS for understanding the optimal location of EV charging networks can serve as a model. Climate change requires the world to act not only fast but also intelligently. In the decades when the internal combustion engine was the automotive standard, opening a petrol station required a less complex chain of analysis. Although it was never a business proposition without risk, an interested party could more easily understand the calculations involved.

The EV transition, however, involves a great deal more speculation. It means balancing predictions of what is likely to happen with what needs to happen. The installation of charging networks requires a knowledge of social patterns and technological requirements. The same could be said for the many changes that global warming is turning into necessities, ranging from alternative sources of energy to better mass transit policies.

Adopting a geographic approach shows an understanding of the complexity of these changes and the upheavals they represent. GIS is a crucial tool for navigating them because the technology operates by treating all variables as interrelated. Maps both illuminate the problems and guide us toward solutions. ▸



"IT BECOMES VERY REALISTIC, AND YOU CAN REALLY UNDERSTAND HOW THE NEW DEVELOPMENT WILL LOOK IN THE CURRENT CONTEXT AS WE EXPLORE DIFFERENT SCENARIOS."

—SVANTE GUTERSTAM,
STRATEGIC COMMUNITY PLANNER, CITY OF UPPSALA

Uppsala, Sweden, Creates a Detailed Digital Twin to Enhance Sustainability

In Europe, new levels of sustainability are being devised, such as in the city of Uppsala, Sweden, which is set to grow by 350,000 people by 2050. The city has taken a pledge to be fossil fuel free by 2030, and a sophisticated digital twin has helped design new patterns to meet that ambitious goal. The digital twin allows planners to test scenarios, looking at such things as shadows, water and stormwater processes, whole streetscapes, and the mix of transportation options that will be needed. With this modeling and testing framework, the plan's value has been proven and residents are shown how things will work better, helping them share in the excitement and adapt during the disruption of the transformation.

Uppsala is Sweden's fastest-growing city. Part of the attraction is the city's reputation as a research center and its ambitious sustainability policy. To handle growth, city planners in Uppsala are creating a new southeastern city district.

Early in the planning process, the planning team struggled with the amount of tabular data regarding project requirements. The number and size of spreadsheets grew, and data in that format made it difficult to engage and collaborate with the multiple city departments involved. It was also difficult to share and conceptualise a physical representation of the complex district plan.

The team developed a planning digital twin of the area that depicted what the project would look like and how it would fit into the larger geographic context of the city. The 3D model is built on top of a digital elevation model using data captured with lidar scanners to show the real topography as well as buildings and trees.

The model provides a way to see the whole of the project. Planners use it to test approaches and reconfigure plans to meet ambitious goals to be climate positive by 2050. It provides the means to inform residents and gather feedback. The planning digital twin enables the city and its residents to make informed and sustainable decisions. ■

LOCATION INTELLIGENCE AND SUSTAINABLE AGRICULTURE

John Deere

By 2030, the global population will reach 8.6 billion. Feeding so many people is a top priority for policy makers and the farmers John Deere supports. The United Nations has established sustainable development goals including eradicating hunger, alleviating food insecurity, and establishing sustainable agricultural practices by 2030.

John Deere plays an important role in supporting the farmers who will achieve these goals. Guiding farmers to improve yields has been a hallmark of the company since it was founded as a tool manufacturer in 1837.

Though its mission remains the same, John Deere now looks and acts more like a technology company than an equipment company. At John Deere Labs, data scientists pursue research around the subject of precision agriculture and site-specific farm management. This work gives farmers the location intelligence they need to increase crop yields by varying resource allocation within a field. John Deere's innovation in this area has elevated field monitoring and location intelligence by applying the branch of artificial intelligence known as machine learning.

Dr. Angela Bowman works to help John Deere advance environmental sustainability from the local level to the very top of the company.

"Computer vision is helping growers see beyond our human capacity—what is happening at those critical junctures between plant and soil, plant and machine, and plant and weather—to help growers make important, in-the-moment decisions," explains Bowman.

Farmers face a number of unpredictable challenges each growing season as weather patterns, climate change, pests, and economic conditions all affect output and profitability. In the face of so much uncertainty, John Deere is empowering farmers with location intelligence to make real-time, analytics-fueled decisions about each of their crops and fields. ▸



One technology John Deere pioneered uses GIS, equipment sensors, and machine learning to allow farmers to spray herbicides directly on individual weeds, reducing chemical use by about 95 percent. In a billion-dollar industry, with so many factors in play, enabling farmers to manage their fields at the micro level adds up to significant environmental impact as well as improved profit margins.

John Deere has been at the forefront of precision agriculture since the 1990s and continues to advance the digital agriculture industry today, thanks to advances in sensor technology. "The data collected from the sensors also helps farmers to build maps of seed populations as well as specific field conditions and yield, informing not only decisions this year but for future years as well," says Bowman.

Technology inside John Deere's row planting machinery ensures that seeds are placed optimally to have the best chance of producing healthy plants and to grow crops equally across a zone or field. Using that same technology, farmers can see exactly where seeds are planted in their fields and apply that insight to more effective decision-making all season long.

Farmers are taking further advantage of their smarter, more agile machines by using John Deere satellite imagery to monitor a number of environmental factors in their fields, including weather patterns, pest impacts, and water table levels. By combining real-time conditions on the ground with historical data about the region on a map, farmers are able to make ecologically smart land-use decisions.

For example, John Deere was recently able to help a farmer make a critical decision about where to install artificial tile drainage in a valley that has historically flooded. The John Deere team used satellite imagery and underlying geographic data to pinpoint exactly where to place the tiles.

In another example, John Deere is helping farmers protect plants once they're in the ground. Although fields are typically only planted and harvested once each year, they are cared for many times during the season. John Deere developed location-based technology to inform farmers exactly where machines are in the field, within centimeters of accuracy. This guides the machines down the right path and ensures that they don't run over any fragile plants. John Deere is one of only five companies that has its own global satellite correction network to enable such precision.

John Deere leadership is expecting location intelligence to play an increasingly important role in the agricultural industry. According to Bowman, "The focus of the agricultural industry over the next five years will be on how to design and deliver automated machines that are smarter and more efficient and that respond to every square foot of farmable land, delivering dramatic improvements in profitability and environmental sustainability for a changing world." ■



LOCATION INTELLIGENCE TO KEEP PEOPLE MOVING

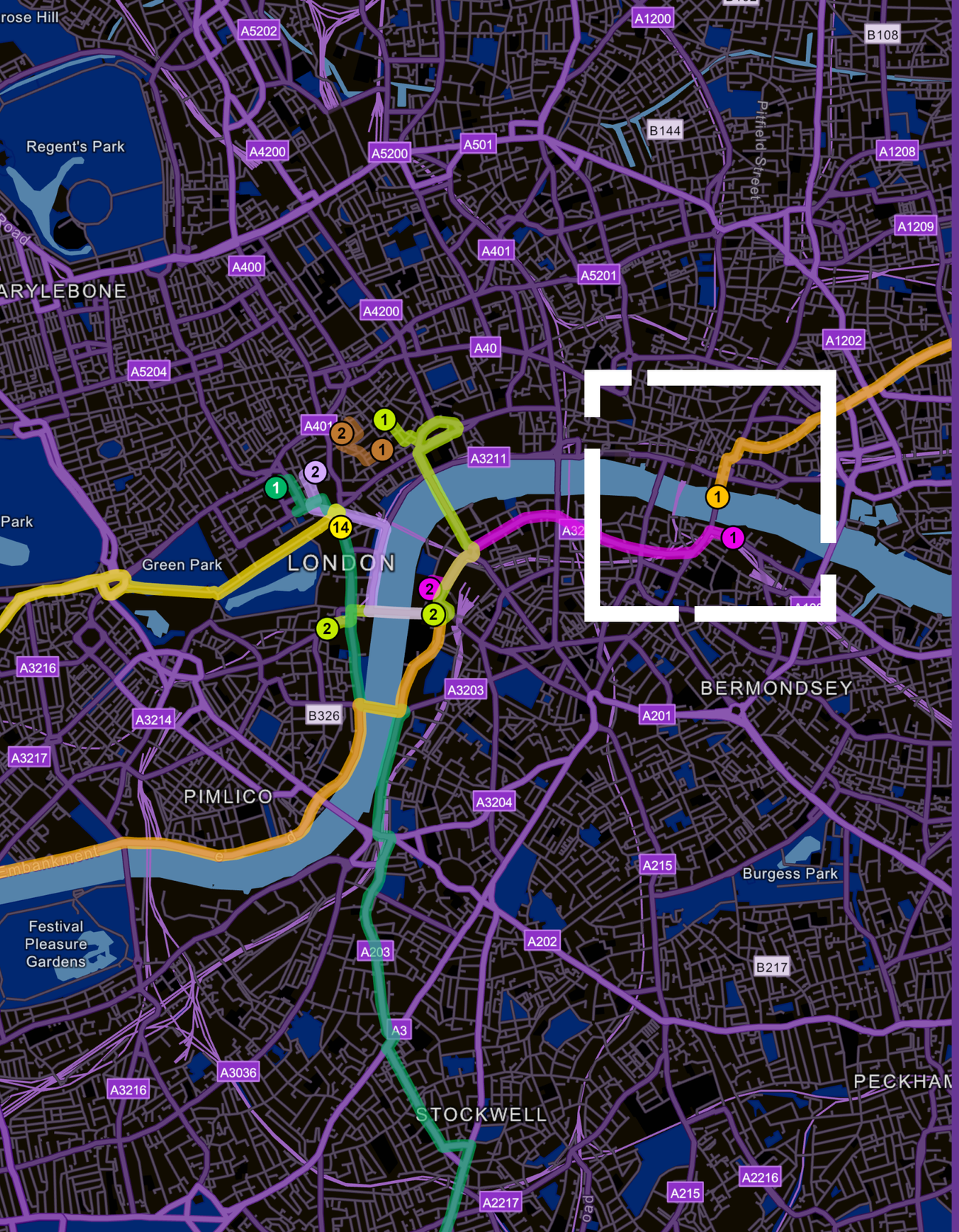
Transport for London

Every day, three million people ride public transportation in London, the United Kingdom's largest city. The number of passengers equals the total population of the next four largest British cities. Planners at Transport for London (TfL), the city's transit authority, move these people by using a geographic approach that balances demand by searching for ridership patterns. TfL uses location intelligence every day for every journey and gathers ridership information to inform maintenance and expansion of the system.

The evolution began during the 2012 Olympic Games, when TfL employed location intelligence to deal with a 20 percent increase in daily ridership. By adding sensors to trains and buses and monitoring security cameras, TfL created situational awareness that allowed it to assess real-time changes in traffic patterns. TfL credited this awareness with mitigating bottlenecks and breakdowns to keep the city moving when ridership reached record levels.

A GIS-based traffic management tool called the Games Playbook helped planners visualise the increase in traffic and create contingency plans for different scenarios. The plan and the real-time view of traffic allowed TfL to send advisories to travelers. "That's the biggest legacy in terms of behavioral change," Michelle Dix, TfL's planning director at the time, told the BBC. "We proved that by giving people alternatives so they can make informed choices, you can manage these big events."

After the Olympics, TfL began a strategy that combined messaging and a geographic approach, sharing location intelligence with key stakeholders and across the organisation. ▸



Adapting Strategy to the Global Pandemic

In 2014, TfL kicked off a 10-year plan, known as the Surface Playbook, to connect its many directorates managing London's aboveground transportation, including buses, trams, light-rail, commuter trains, passenger ferries, the Dial-a-Ride transport service for people with disabilities, London's congestion pricing program, and the taxi licensing office.

GIS allowed these diverse stakeholders—already united in the goal of keeping Greater London's interlocking transit systems running smoothly—to see current traffic conditions through a single source of truth.

The Surface Playbook effort proved vital when the pandemic hit. Using the maps the transit authority had already created, TfL applied the communications and public affairs skills honed during the Olympics to encourage safe active modes of travel.

The program was designed "to support the members of the public to have more confidence to walk and cycle," explained Jaymie Croucher, TfL's lead for GIS. "It's focused on supporting sustainable modes of travel and increasing the ability to enact social distancing in transit whilst limiting the impact of other modes."

From big-picture perspectives to street-by-street analysis, the program had an important equity component, using maps to make sure no London community remained isolated during the lockdowns. TfL's GIS team identified at-risk and high-demand areas of pavement, based on five major factors: use by cyclists and pedestrians; essential services; population density; low-income neighborhoods, which usually have above-average amounts of foot traffic; and public transportation hubs.

Maps revealed which streets were likely to be the most crowded and where more space was needed for safe and physically distanced activity. Risk assessments could even be layered over maps of walkway widths to identify capacity while keeping everyone spread apart. Measures included widening walkways, creating temporary bike lanes, and restricting the use of cars on some streets. ▸



Continuing the Process as the Pandemic Fades

As the pandemic wanes, the Surface Playbook has been instrumental in crafting a cautious return to normalcy. TfL officials are using GIS to determine which pandemic measures and active transportation routes should be considered permanent.

"Before we can decide whether a feature becomes permanent or not, we need to understand what the impact is," Croucher said. "If you close a street, for example, that is going to cause traffic to develop elsewhere."

On-site surveys have been a key component of the monitoring process. Surveyors across the Greater London area capture data about use, safety, and needed improvements. Survey feedback populates a live, online GIS dashboard, providing real-time visibility and informing next steps for city management.

Shareable reporting tools have also supported TfL's expansion into new parts of the city. With many transportation projects being carried out by the boroughs within London, a GIS database centralises information and makes essential data widely available.

"Compiling it all within a single portal, we've allowed everyone to have transparency over the safety of each scheme and compliance of users," Croucher said. The portal delivers situational awareness for TfL and city leadership to see how each plan performs and interacts.

Changing a city's transportation habits ultimately requires a strategic rebalancing of the way residents use city streets. Recreation, public transit, transportation of people and goods—each claims a space. Giving more space to one will necessarily take space from another. Maps provide a powerful visual understanding of the space available and a strong platform to plan, prioritise, and improve its uses.

"The benefits of the way we collect and disseminate this information are reaped well beyond TfL to provide clarity to both external partners and, ultimately, the public," Croucher said. "Understanding the spatial relationships that elements have provides a clear picture for decision-makers that you won't necessarily see by looking through more traditional means such as a database or a spreadsheet." ■



AMSTERDAM'S AIRPORT FLIES HIGH WITH CUTTING-EDGE DIGITAL TWIN

Amsterdam Airport Schiphol

Major airports present some of the most complex infrastructure challenges. They are sprawling facilities stretched across parcels of land the size of small or even midsize cities. Thousands of people pass through them on any given day. They are 24-hour-a-day facilities, and any internal problems at a major airport need to be solved while it remains open.

Around the world, airport authorities have discovered that GIS-based digital twins offer the optimal way to understand this complexity, strategise to solve problems as they arise, and plan for needed future developments and upgrades.

And those airport authorities often look to Amsterdam's Schiphol Airport, the world's second-largest connective aviation hub and the 11th-busiest airport overall.

The airport was an early adopter of GIS technology. As early as the mid-1980s, airport management used GIS to oversee important business operations. ▸

Cutting-Edge Digital Twin

In 2017, as part of a multiyear capital improvement program, Schiphol added several digital assets within new construction projects. The airport authority also built a digital asset twin of the airport. The digital twin, known as the Common Data Environment (CDE), organises data in different formats from various sources. The CDE can integrate building information modeling (BIM) material, GIS data, and data that is collected in real time and describes project changes. The CDE also provides a way to include financial information, documents, and project portfolios.

The digital twin collects and processes data from remote sensors at the airport that are used for predictive maintenance. Within the 7,000-acre complex, the airport tracks and maintains more than 80,000 assets—both indoor and outdoor—including runways, lighting systems, information booths, and fire extinguishers. The digital twin also allows the airport to run simulations on potential operational failures throughout the airport complex.

Schiphol's digital twin helps facilitate construction projects. Contractors provide construction data in an open format for standardising BIM data. This information-rich model is used for analysing design operations and creating visualisations.

The CDE includes a 3D web scene that gives managers, technicians, contractors, and other stakeholders a detailed view that shows the status of the construction process. The 3D web scene also functions as a dashboard for the asset management process. ■

AUTOMATING ROAD CONDITION ASSESSMENTS IN GERMANY

Bavarian State Ministry of Housing, Building, and Transport

Bavaria's centralised location makes the state not only a crossroads to reach several towns in Germany but also a common stop for travelers passing through on their way to other countries. The state's 23,000 kilometers of roads represent €40 billion in fixed assets.

One of the most well-traveled routes in Bavaria is Bundesautobahn 70. The heavy volume of traffic takes a toll on the road's conditions. For the past several years, the Bavarian State Ministry of Housing, Building, and Transport has strived to make road maintenance on the highway more efficient by predicting when and where it will be needed.

The transport office used a deep learning program trained to log and process indicators of road conditions. Working with a team of data scientists, officials presented the computer with road condition and traffic history data. The highway was divided into 4,800 segments, each 100 meters long. A GIS program served two functions—it provided a way to visualise the data and perform preprocessing tasks, such as noting areas where highways overlapped. Using the data, the ministry developed a deep learning model that could detect when road sections would need repairs, by analysing features such as pavement thickness and road conditions.

Among the findings, the program revealed that curved areas of the highway were most at risk for needing repairs. These could be prioritised for repaving. With GeoAI, the task of combing through reams of data—which would've taken analysts hundreds of hours to pore over—can now be done swiftly and automatically as part of ongoing workflows. ■



THE BUSINESS VALUE OF SUSTAINABILITY

Nespresso

"WE ARE WORKING QUITE EXTENSIVELY TO UNDERSTAND THE IMPACT OF CLIMATE CHANGE AND EXTREME WEATHER AROUND FARMS AND ALSO THE IMPACT OF FARMS ON THE SURROUNDING ENVIRONMENT."

—YANN DE PIETRO, OPERATIONS AND SUSTAINABILITY TECHNOLOGY MANAGER FOR COFFEE AT NESPRESSO



Photo courtesy of Nespresso.

Innovative companies are adopting big data analytics and location intelligence to drive smart, sustainable practices for long-term growth and competitive advantage. One such company is Nespresso.

An autonomously managed subsidiary of Nestlé Group, Nespresso is known globally for its premium single-serving coffees. Key to Nespresso's success and customer loyalty is the company's emphasis on—and investment in—the consistency of its coffee's flavor.

However, coffee is a delicate crop, frequently grown in developing countries and is highly dependent on healthy ecosystems. This leaves coffee—and Nespresso—susceptible to the increasingly volatile effects of sociocultural events and climate change. For Nespresso, acting today to avoid the perils of tomorrow is not just good stewardship; it's sustainable business.

"Sustainability is really at the core of our business. It is imperative to our long-term business success," said Yann De Pietro, operations and sustainability technology manager for coffee at Nespresso. "There have been studies saying that by 2050, arabica coffee may not be available anymore in some countries if we don't do anything now."

The company is working to combat that decline and maintain Nespresso's competitive advantage long into the future. ▸

Nespresso works with more than



Photo courtesy of Nespresso.

Controlling Challenges through Sustainability

Nespresso works with more than 100,000 farmers in 13 countries, up from 300 farmers 15 years ago. In 2003, the company launched its responsible coffee sourcing program, the Nespresso AAA Sustainable Quality Program, in partnership with the Rainforest Alliance. The program is founded on two convictions: that high-quality coffee and the sustainability of farming communities are interconnected, and that only by building trusting, long-standing relationships with coffee producers can Nespresso hope to make a positive difference.

The company supports the implementation of sustainable agricultural practices by investing in technical assistance, paying premiums directly to coffee farmers, and cofinancing infrastructure improvements.

As part of that effort, the company has invested in a network of over 450 agronomists—specialists who provide coffee growers with on-site technical assistance and trainings on practices such as pruning, crop renovation, fair treatment of workers, water usage, and biodiversity conservation.

Through the AAA program, Nespresso invests approximately €35 million per year in technical assistance and premiums paid to farmers for their quality coffee. The educational program is free to farmers and doesn't require them to sell to Nespresso, De Pietro explains. But the benefits to each side help create long-lasting relationships and loyalty.

At the center of Nespresso's sustainability and digital transformation is location intelligence. The company has built a robust monitoring and evaluation system using advanced technology that records, maps, and analyses data about farms, farmers, and coffee crops. Nespresso can assess local feedback, see the status of each farm, and gain insight into AAA's impact. Data analytics powered by GIS also reveal insights into the way farmers deliver coffee beans to central mills to be harvested—a key factor in supply chain productivity and efficiency.

One of De Pietro's goals is to help farmers get their crop to market more efficiently. Recent analysis in Colombia exemplified how location intelligence can create business advantage for the company and its partners. The data showed that farmers brought their crops to certain Colombian mills—many of them close to their farms—less frequently than projected. De Pietro used GIS to dig deeper into the data so that he could understand these behavioral patterns. What he discovered was a reminder of topography's effect on time to market.

With basic maps, he said, his team could work out the distance between farms and mills. But only with sophisticated location intelligence could staff understand the true travel distances to each central mill. Applying an analysis that was similar to one on the frequency of agronomists' visits to Nespresso's AAA farms, De Pietro and the team found a familiar pattern. The analyses uncovered areas where the terrain between the mills and certain farms required long rides or walks through the mountains, making frequent visits impractical. ▸



Photo courtesy of Nespresso.

Progress through Digital Transformation

In both cases, location intelligence pointed the way to better business and sustainability practices. If the mills were more centrally located, farmers could get coffee to market more quickly. And when the agronomists can reach farms faster, they hasten the day when 100 percent of Nespresso's coffee is sourced from sustainable farmers.

Today Nespresso is using location intelligence from GIS to build a comprehensive understanding of climate and geography around its farms. "We are working quite extensively to understand the impact of climate change and extreme weather around farms, and also the impact of farms to the surrounding environment," De Pietro said.

The use of location intelligence to shed light on the granular details of day-to-day coffee farming sets Nespresso apart. By examining locations for farmers, the company frees up precious time and increases productivity. This impacts not only farming but also time for education and strategic planning—the very activities Nespresso hopes will sustain its coffee crops far into the future.

Nespresso's core product and the heart of its brand—coffee—is at risk from climate changes in coming years. The company is approaching these challenges proactively, taking steps to not only mitigate risk but also use location intelligence to create strategic differentiators.

Treating sustainability as both a guiding principle and an opportunity to gain competitive value may be the way forward for other innovators in the business community. ■



About Esri

Esri, the global market leader in location intelligence, offers the most powerful mapping and spatial analytics technology available. Since 1969, Esri has helped customers unlock the full potential of data to improve operational and business results. Today, Esri software is deployed in more than 350,000 organisations including the world's largest cities, most national governments, 75 percent of Fortune 500 companies, and more than 7,000 colleges and universities. Esri engineers the most advanced solutions for digital transformation, the Internet of Things (IoT), and location analytics to inform the most authoritative maps in the world.

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