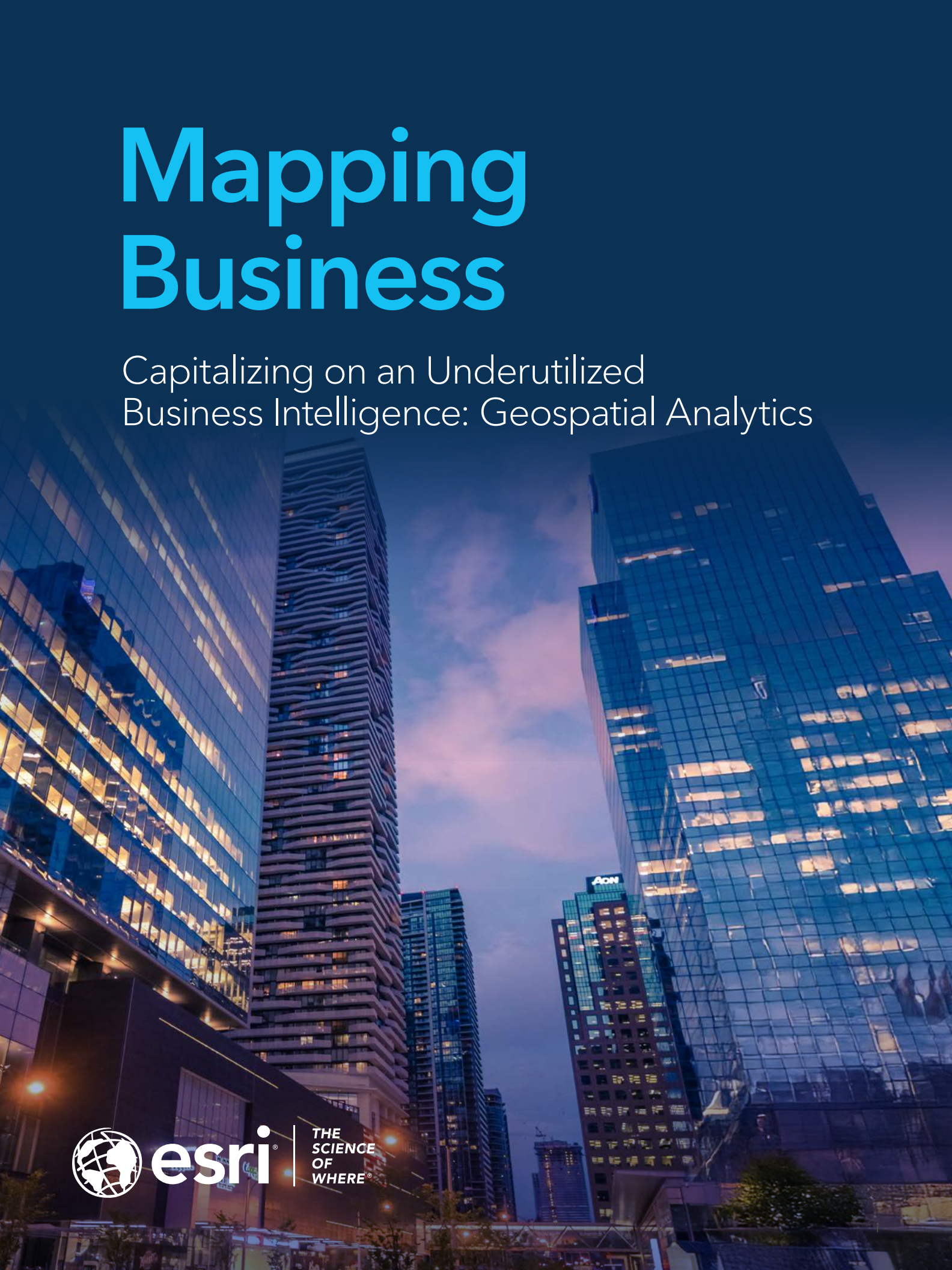
Mapping Business

Capitalizing on an Underutilized Business Intelligence: Geospatial Analytics



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MAPPING BUSINESS CONTENT

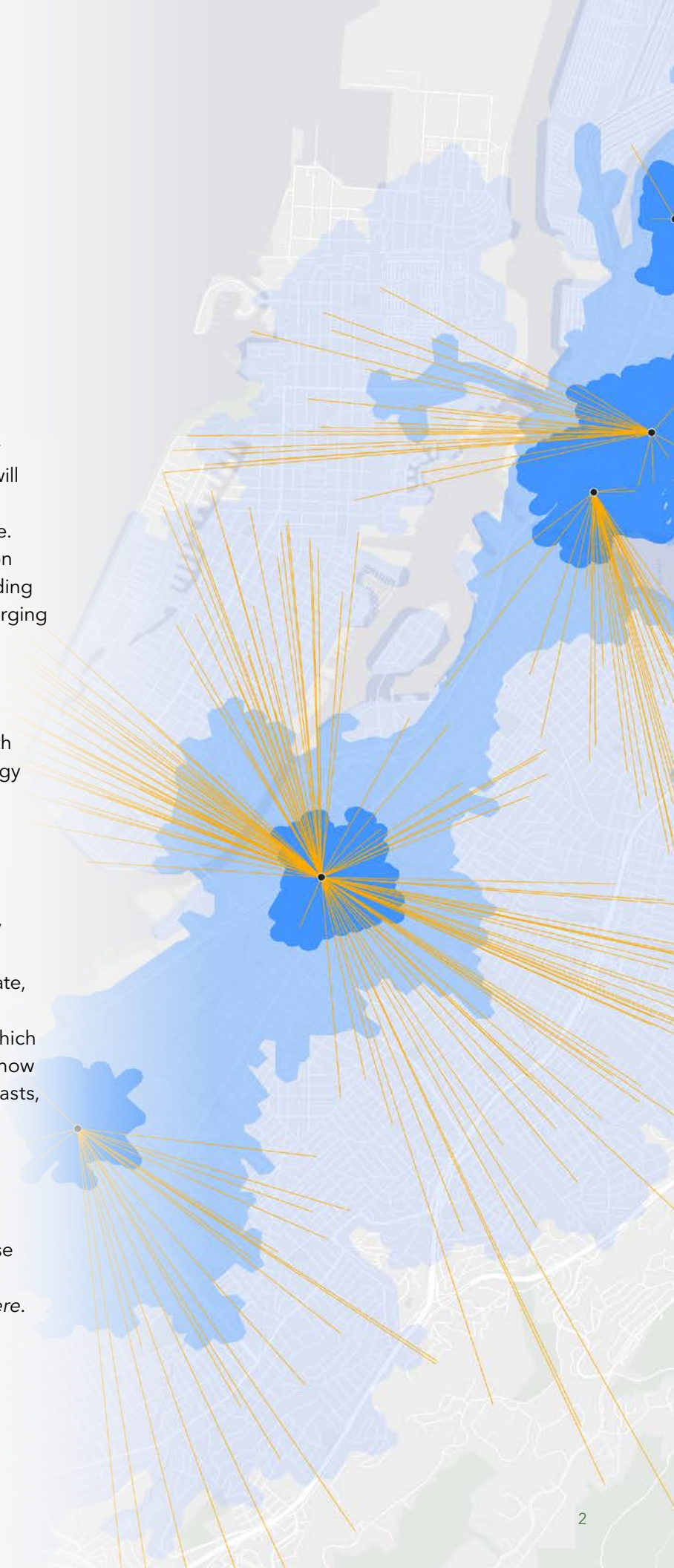
The BIG IDEA

Does the next decade promise opportunity or risk? Savvy business leaders recognize that it will deliver both, and they're facing that challenge with an enhanced form of business intelligence. These forward-thinking companies use location technology and data to cultivate clarity—providing a consistent view of their market position, emerging risks, and pathways to strategic opportunities.

From Fortune 50 corporations to midmarket leaders and innovative startups, they're enhancing traditional business intelligence with geographic information system (GIS) technology to create actionable location intelligence.

In a world characterized by economic unpredictability and environmental volatility, clarity becomes the next decade's most valuable C-suite asset. GIS delivers this clarity by integrating crucial location context to enterprise-wide decisions—spanning real estate, marketing, risk management, finance, supply chain, and operations. Whether identifying which suppliers lie in a typhoon's path or analyzing how demographic shifts will impact revenue forecasts, GIS transforms complex data into strategic intelligence through the power of location.

As the next decade unfolds its risks and opportunities, the companies positioned for sustainable growth and resilience will be those that use geography to enrich their business intelligence with the critical dimension of *where*.

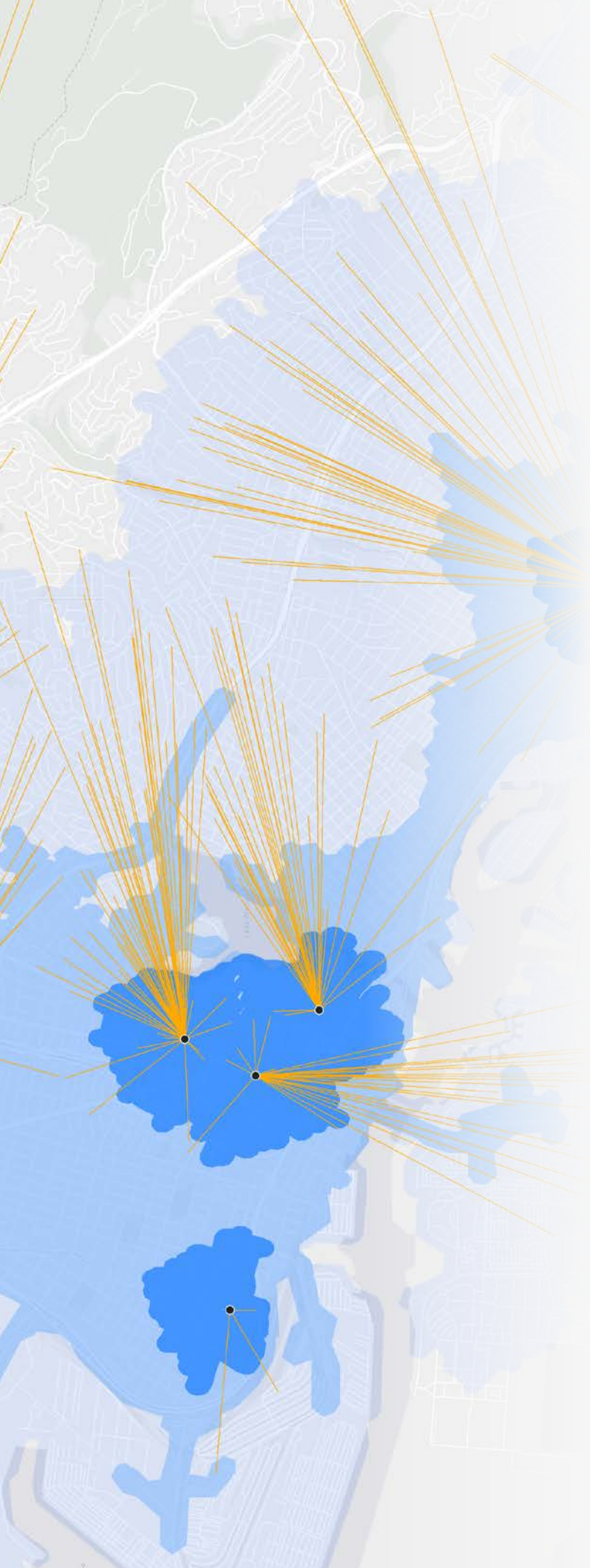


KEY CONCEPTS

The Era of AI–Accessible Intelligence: Artificial intelligence has finally become so sophisticated that it's now easier to use for analysis, rather than harder. For a knowledge system like GIS, that means analysts can extract insight from data faster than ever, and even nonexperts can use it. As a result, location analysts and data scientists are bringing geospatial clarity to the business intelligence executives rely on—and everyday professionals are accessing new sources of location intelligence for faster, smarter decisions.

Finding Competitive Advantage in Resilience: Most companies approach resilience defensively—as a necessary shield against risks that could damage their bottom line. But forward-looking executives see resilience as something more powerful: a competitive advantage. These leaders have developed sophisticated spatial analysis capabilities that allow them to anticipate threats, protect assets, secure sustainable supply chains, and capitalize on investment opportunities while competitors struggle to tread water.

Business Growth and Revenue Acceleration: Visionary companies are leveraging geospatial intelligence to drive growth across their organizations. Marketing teams analyze new markets with unprecedented precision–examining demographics and consumer behavior patterns to pinpoint sales potential. Real estate teams transform from cost centers to revenue generators by mapping and analyzing hidden opportunities in existing portfolios. Finance teams deploy geospatial AI to accurately forecast performance for new locations before breaking ground. The geospatial approach to business intelligence is becoming synonymous with strategic growth.



Introduction

A Location-Rich Form of Business Intelligence Drives Competitive Advantage

Competitive advantage is an ever-shifting target. Consumer tastes change, supply chain capabilities fluctuate, risks rise and fade. Business leaders must sense and respond to these variations—or better yet, anticipate them.

Most successful organizations have evolved beyond traditional business intelligence. Where spreadsheet analysts and data scientists once worked in isolation, they now collaborate with a crucial partner—the location analyst—to leverage transformative geographic insights.

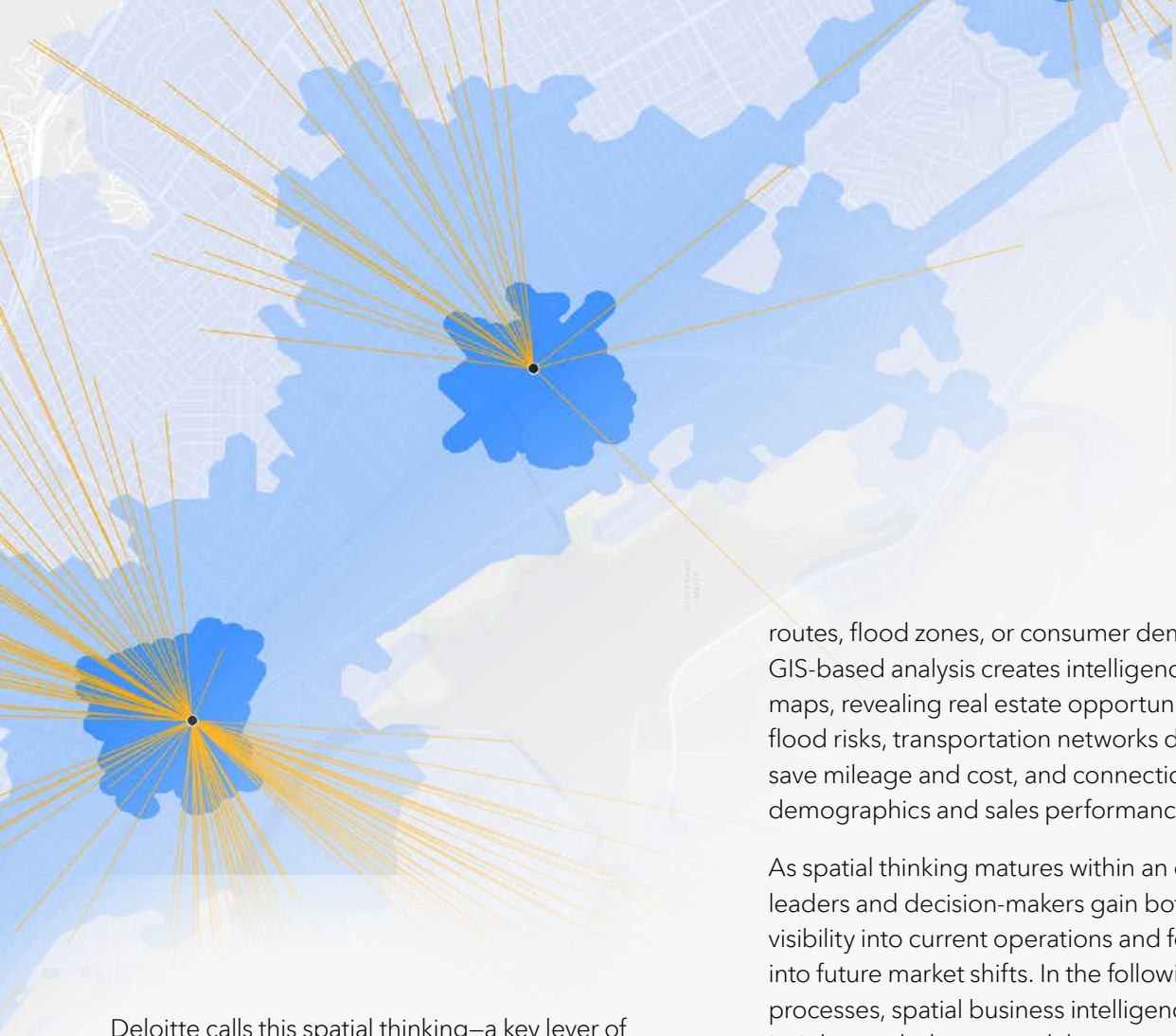
This partnership is the result of a simple realization: Everything in business happens somewhere. A business intelligence strategy that overlooks location isn't merely outdated—it's a critical vulnerability. It leaves organizations blind to pivotal patterns and relationships driving current market dynamics.

Today's industry leaders rely on GIS to enrich and analyze data from other enterprise business systems including ERP, CRM, SCM, and BI. That insight helps answer questions at the heart of the modern enterprise:

Where are our best customers and locations, and where are they likely to be in the future?

Where are our assets or operational locations in danger from water stress, extreme heat, or other physical risks?

How do we redesign our supply chain to serve the business efficiently—now and for decades to come?



Deloitte calls this spatial thinking—a key lever of competitive advantage. Across more than three-quarters of Fortune 500 companies, location intelligence produced by GIS informs the decisions of CEOs, supply chain managers, marketers, insurance adjusters, real estate directors, and risk officers.

Within top-performing companies, spatial thinking is the foundation on which smart processes are built. Warehouse managers discover less costly trucking routes with GIS. Financial planners generate revenue forecasts on prospective acquisitions. Corporate security analysts flag real-time incidents on GIS dashboards, while drone teams survey business locations and use GIS analysis to assess flooding and other risks.

These practices benefit from the sophistication of modern GIS, including AI for simulating outcomes. But at their root is something much simpler—an operational basemap.

An operational basemap is the business unfurled—all its offices, plants, distribution centers, stores, service centers, suppliers. Analysts add data to deepen the basemap, revealing store sales, transportation routes, flood zones, or consumer demographics. GIS-based analysis creates intelligence from these maps, revealing real estate opportunities with lower flood risks, transportation networks designed to save mileage and cost, and connections between demographics and sales performance.

As spatial thinking matures within an organization, leaders and decision-makers gain both unprecedented visibility into current operations and foresight into future market shifts. In the following business processes, spatial business intelligence provides the insight needed to expand the top and bottom lines.

Strategic Planning

In the words of one business school dean, to serve customers well, "CEOs must have both a strategic as well as a tactical understanding of where the business is in the marketplace and how it is performing." Strategic planning has always balanced hard-won instinct with objective data, but today those two forces may finally be reaching an equilibrium. Senior executives now rely on GIS dashboards that illuminate performance across every facet of their operations, creating clear pathways to profitable growth.

Market Planning and Development

Successful companies gain an edge by understanding customers, analyzing markets, and selecting the right locations for their business. With GIS, they do this more quickly than competitors and gain a distinct business advantage. At real estate firm JLL, location technology is accessible to thousands of brokers nationwide, empowering them to advise clients of all sizes on winning expansion strategies.

Business Risk Analysis

As a business grows, so does its risk exposure. Marriott faces that challenge as it invests in properties around the world. The analysis isn't merely about place; it's also about time—gauging the risk a location faces day-to-day and over decades. GIS combines location analysis with geospatial AI to bring future risks to light, allowing companies to make the right investment decisions today and enact the right mitigation measures for tomorrow.

Operational Efficiency

Maximum output for minimum input—for executives, this can be an elusive goal. Many have discovered that spatial thinking transforms how business operates, eliminating wasted effort, streamlining operations, and accelerating decision-making. GIS technology has also been a lever for efficiencies across an unexpected spectrum of industries, as the stories in this ebook demonstrate.

Supply Chain Optimization

Companies that outperform the competition recognize geography as more than a spot on a map or a single attribute. They see it as a framework. Executives use geography to ask questions about the whole business, including how to operate and optimize it. This often leads to the supply chain, where innovation is nearly always anchored in geography. For global stalwarts like FedEx and Cisco, the results of supply chain optimization have been game-changing.

Operations Safety and Security

While the COVID-19 pandemic has receded, its impact on business processes persists. During the pandemic, companies became more aware of employee vulnerabilities along with the need to identify and avoid risks to employee health and the health of the community. Today, that practice transcends public health, helping safeguard employees at Duke Energy as they perform service calls and providing a vital lifeline to BP Bioenergy workers operating in remote locations.

Enriching Data, Analytics, and Apps

A decade ago, CIOs began collaborating with chief data and analytics officers, bulking up business intelligence teams, installing data lakes, and purchasing third-party data. Top performers quickly learned how much more insightful their analysis could be—and how valuable customer apps could become—when geographic context is factored in. Companies like Rently and other app makers used location services to direct customers and employees precisely where they needed to go.

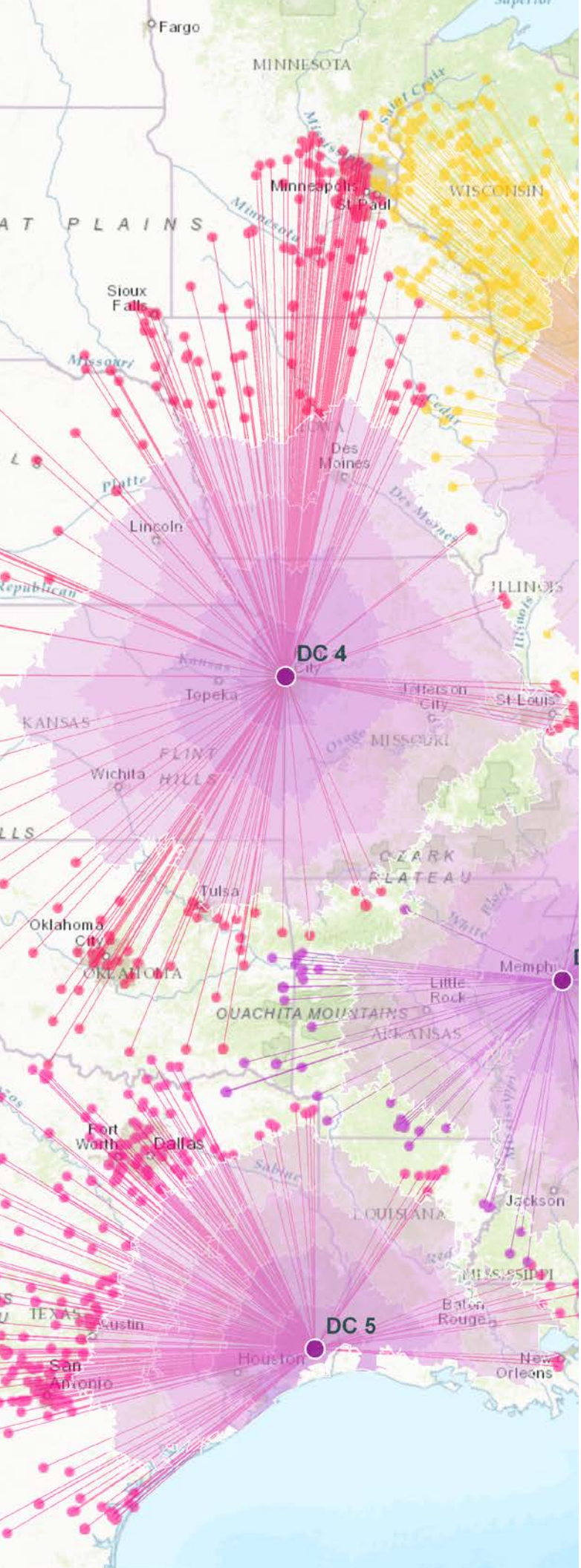
Throughout the stories in this book, a fundamental spatial truth emerges: Companies cannot chart their future without first understanding their present position. GIS technology provides this essential awareness, continuously revealing both opportunities and threats in the business landscape.

These stories demonstrate how GIS has evolved into indispensable enterprise technology, delivering the strategic intelligence companies need to master daily operations, fortify long-term planning, and gain a decisive competitive advantage.

Learn more about what ArcGIS® can do for your business.

Strategic Planning

Spreadsheets filled with financial projections may never go out of style in the C-suite. But when it comes to truly seeing the business–understanding markets, analyzing operations, and designing strategy–interactive maps provide insights that numbers alone cannot reveal. The ideal view of a business is a spatial one.



Strategic Planning (continued)

At Big Four consulting firm KPMG and financial stalwart Diebold Nixdorf, strategic planning is often performed on a client's behalf. At ExxonMobil, the strategic view encompasses a massive real estate portfolio, with an eye toward hidden opportunities.

The unsung hero in each case is data. Finding data, cleaning it, analyzing it, and presenting it are key to understanding where a business is and how it needs to move forward. As Forrester analyst James McCormick said on a recent podcast, "We need to have data and analytics technologies that deliver strategic value, not just the typical ROI kind of value. And that value needs to differentiate us. So, we need to understand our businesses, our customer, our processes in such a way that it delivers this differentiation."

KPMG clients are accustomed to receiving actionable advice grounded in reliable data. Such guidance helps private equity firms, agencies of the federal government, and Fortune 500 companies set strategy and plan investments. To ground-truth its findings, the consulting firm spends millions on data each year and relies on a team of data scientists and GIS analysts to convert the raw information into meaningful advice.

Diebold Nixdorf uses GIS technology to advise its clients on banking strategies, detailing everything from the number of households with checking accounts in a suburban market to the prevalence of Gen Z residents with a tech-first approach to banking. In an industry roiled by change, it's the kind of strategic advice that helps turn upheaval into opportunity.

For businesses determined to maximize their assets, indecision proves just as costly as poor decision-making. ExxonMobil's real estate optimization team has become a strategic weapon by using GIS to create a global view of the company's properties and uncover revenue-generating opportunities. Where team members once needed months to deliver spatial insight for critical executive decisions, they now deliver the information in seconds.

The Location-Savvy Consultant

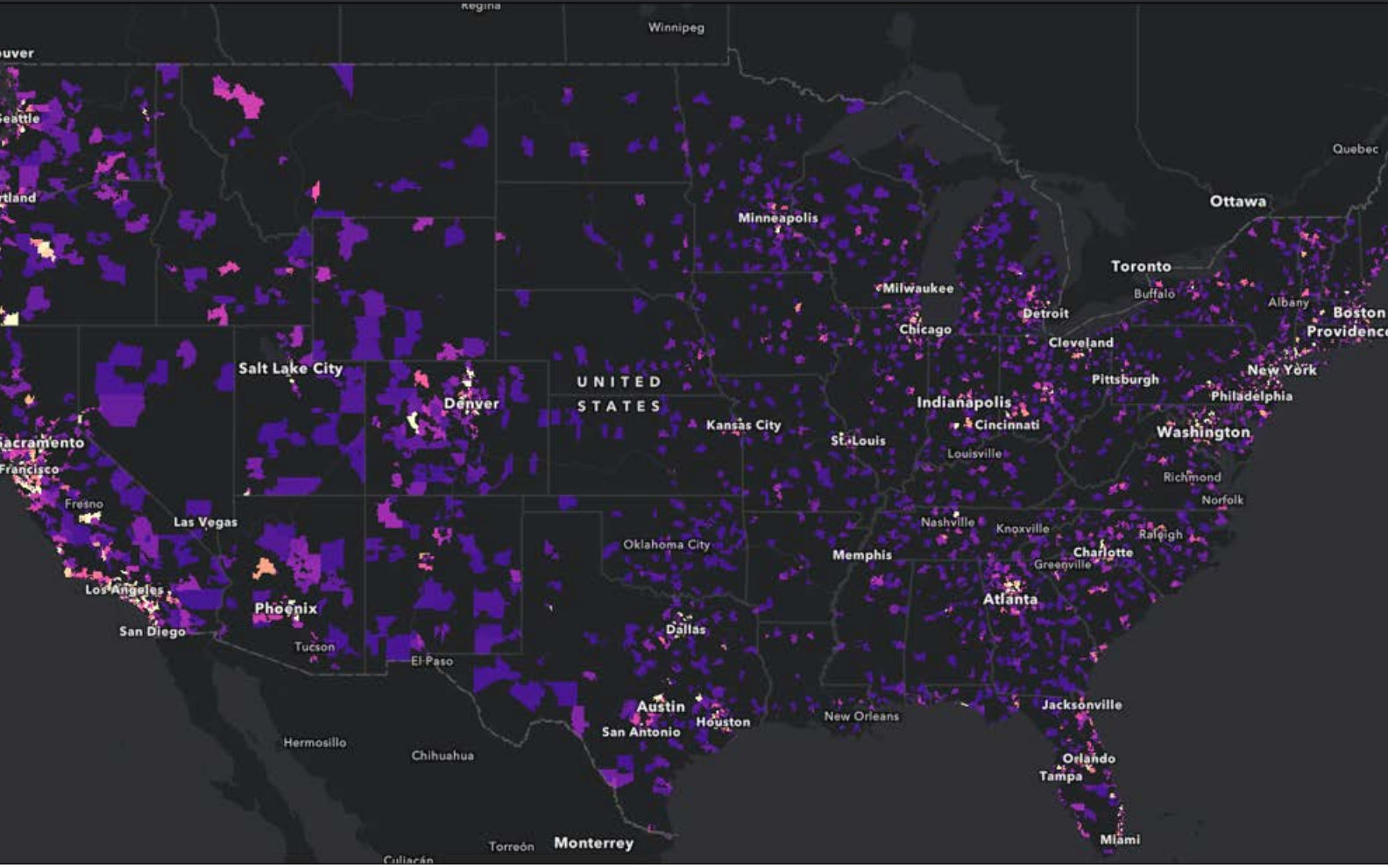
To see how a business is performing, a CFO might conduct a four-wall analysis, examining factors inside a location that impact profit and loss, including labor costs, sales, and the cost of goods sold.

The exercise might explain internal dynamics—but it neglects important context. To plan effectively, C-suite leaders must interpret the far more complex, fluid landscape surrounding their operations. But shifting trade routes, environmental regulations, tax incentive zones, and geopolitical trends don't fit neatly into spreadsheets.

"You can't separate business from its location because that space defines its people, its cost, its customers," says Tom Schenk, managing director of analytics at KPMG.

Businesses often turn to consulting firms like KPMG for guidance on adapting to the fluctuations of the global economy. Now, Big Four advisory firms are augmenting their strategic expertise with GIS technology.

With in-house geospatial capabilities, consultants develop guidance tailored to clients and the locations where they operate.



> "You can't separate business from its location because that space defines its people, its cost, its customers"
>
> -Tom Schenk, KPMG

Through the business insights generated by GIS, known as location intelligence, a Big Four firm like KPMG can match a real estate portfolio manager with a qualified opportunity zone to invest capital gains. A KPMG consultant can create a smart map with demographic and zoning data to help an e-commerce company find not only the best city for a brick-and-mortar store, but the best shopping district and street.

"Almost every single engagement we have, whether it's a financial due diligence project or if it's a buy-side or sell-side strategy, there's a locational aspect to it," says Dennis Latto, the company's director of analytics and head of GIS.

Location Awareness Among the Big Four

KPMG incorporated GIS as an enterprise technology last year to deepen the expertise it offers to high-powered clients including private equity firms, departments of the federal government, and Fortune 500 companies.

The geospatial technology platform helps KPMG consultants extract value from the roughly $5 million of third-party data the organization invests in each year. Insights derived from geographic patterns in credit card transactions or 5G cell phone towers help clients strategically position themselves in fields such as real estate analytics or electric vehicle (EV) infrastructure planning.

Turning to Spatial Analysis to Answer the Why Questions

When it comes to assessing location options, the business mindset has broadened, Latto says. "Now it's, Why is it good? Why is it bad? What are the drivers affecting our business outside of the box of the location that we're at?"

Spatial relationships define much of a business's value chain, whether it's the distance between a grocery retailer and its competitors, or the layout of a supply chain. Location software brings key relationships to light and unpacks the implications for decision-makers.

When an artificial Christmas tree company wanted deliveries to reach 99 percent of customers within two days, KPMG's GIS team helped optimize the distribution network, balancing delivery times with the lease rates and labor costs in different locations.

For a client assessing a site for a solar project, location analysis could surface several parcels with a similar grade of land, and identify one that provides a special tax abatement to expand the size of the project.

> "The value of working in a firm like KPMG is the analytical horsepower we could bring to the market and to our clients. We have integrated geospatial analytics and data science to support this effort."
>
> -Michael Stacey, KPMG

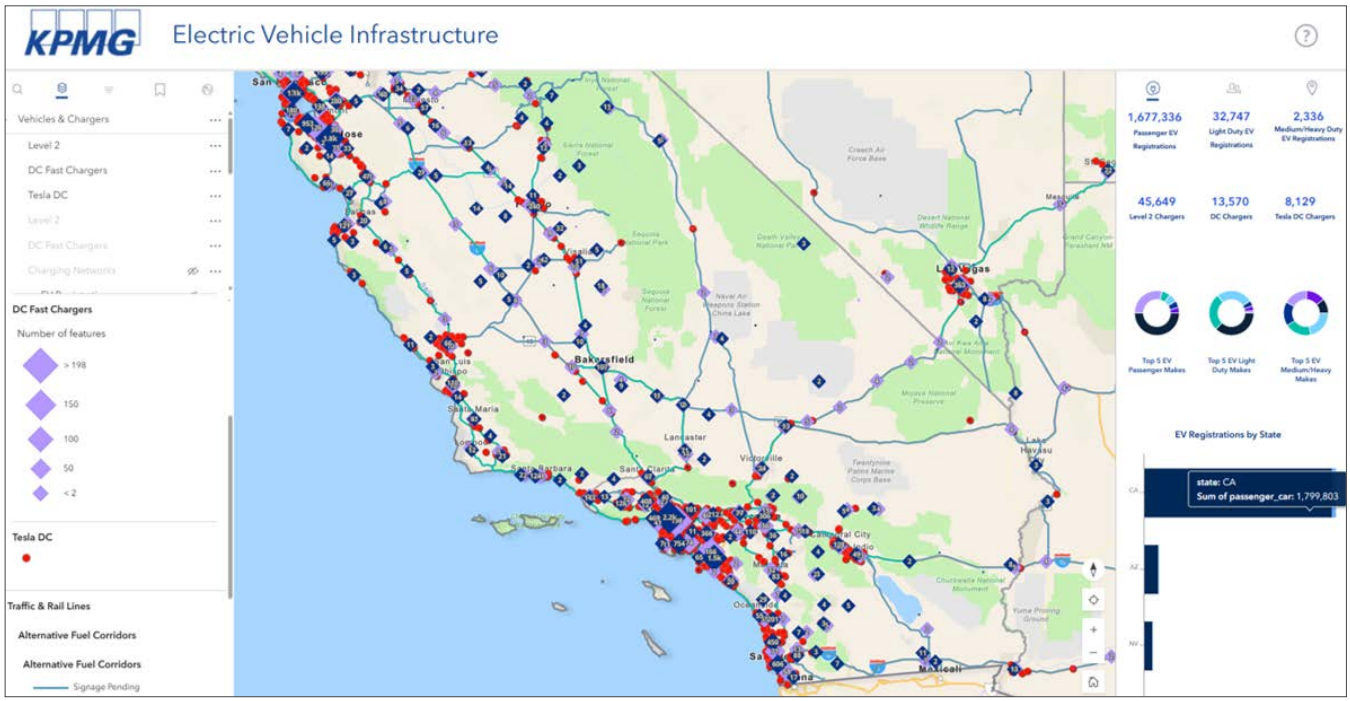
The Changing Landscape of Big Four Consulting

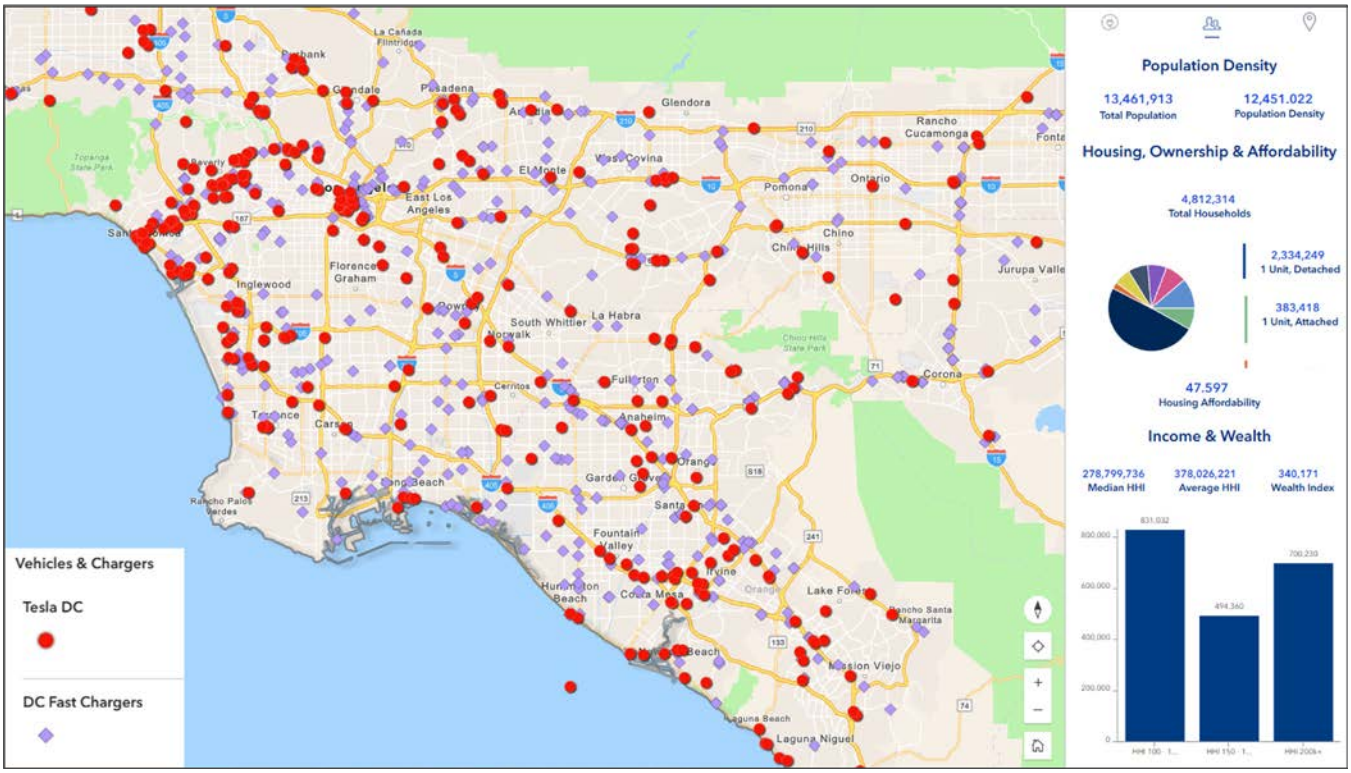
Today's business leaders are building more sustainable and equitable organizations. As they do, they expect new forms of guidance from Big Four consultants. This includes deliverables like interactive maps and dashboards that are more dynamic than the slide decks that have been consulting's lingua franca for a generation. Specialists in data technologies like GIS and AI are in demand.

Mindful of those changes, Schenk, who oversees an advanced analytics team that combines GIS with data science and software development, pushed KPMG to enlarge its geospatial capabilities. "It's going to allow our business to interact with information and data like they haven't been able to before," he says.

Schenk first realized the potential of geospatial technology in his former role as Chicago's chief data officer. His department created a situational awareness platform as the city prepared to host NATO and G8 members.

"We needed to understand what was happening everywhere," Schenk says. "Geospatial became crucially important."





GIS software wove together data on 911 calls, weather reports, the location of city-owned vehicles, and other metrics to provide a real-time picture of event management.

At KPMG, Schenk manages a team of data scientists, GIS and AI specialists, mathematicians, engineers, software developers, and business intelligence analysts. Schenk and Latto, who led the effort to build the organization's geospatial platform, have already seen GIS enhance collaboration among data scientists, deal teams, and KPMG leadership. Instead of employees manually editing a slide deck, a location-aware dashboard brings trends to life by displaying and updating data visually, streamlining the flow of information.

"The prevalence of location data is so far and broad, it can't be treated as a specialized form of analytics anymore," Schenk says. "The landscape has completely changed."

Consulting on the EV Gold Rush

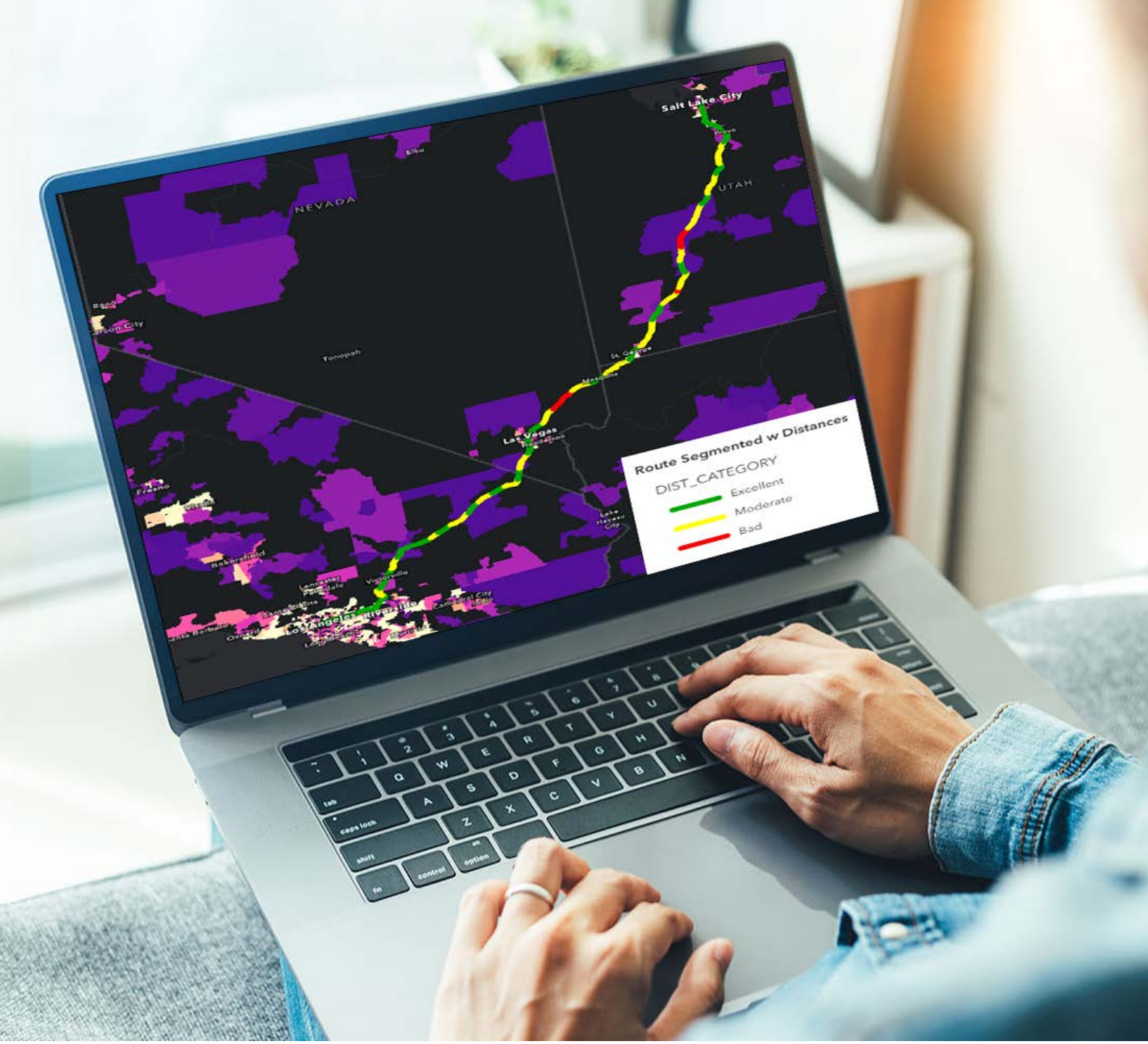
Thanks in part to an influx of federal funding, Big Four consulting firms are seeing ballooning demand for strategic expertise in the EV market.

The Infrastructure Investment and Jobs Act (IIJA), for instance, allocated $7.5 billion to build a national network of electric vehicle chargers, and the Inflation Reduction Act (IRA) and the CHIPS and Science Act include provisions to boost electric vehicle development. Over the past year, EV and battery makers have committed to investments of at least $52 billion in North American supply chains.

"We kind of call it the gold rush right now," says Michael Stacey, a KPMG director based in Cleveland, Ohio, who consults on infrastructure and climate. Stacey teamed up with Latto and Schenk to leverage GIS technology in developing KPMG's electric vehicle infrastructure insights platform.

With this platform, consultants can cater to state department of transportation planners as well as private developers. Location technology makes sense of drive patterns, demographics, and electric power transmission networks. Stacey calls GIS "the analytical horsepower behind a lot of what we do in our infrastructure practice."

The decision-makers overseeing EV charger placements need to factor in elements like access to power, where chargers are most likely to be used, return on investment, and service to disadvantaged communities.



The spatial framework of KPMG's insight platform helps address classic questions of where to play and how to win, as well as newer equity-related concerns. "To be able to inform those decisions, a GIS tool is going to be critical," Stacey says.

Consultants: The New Data Innovators

As the use of GIS spreads among KPMG consultants and data professionals, its value lies in making sense of what Schenk calls "blobby data"—data from networks of roads, sensors, trade areas, and other areas of the built environment. Tables can't capture the growth of those networks. But with GIS, Big Four consultants can combine multiple layers of information and find the patterns that unlock business value for clients.

Data aggregators are important, but the value they deliver can be limited, Latto says. "We are data innovators, blending different datasets to create something unique. A new perspective or new insights for our clients is one of the big driving factors that we work on every day."

Creating an Operational Basemap

Business leaders can't capitalize on what they can't see. For those operating in a data-saturated environment, gaining an unobstructed view of the entire organization is a major priority.

The operational basemap has emerged as one of the best ways to help decision-makers see business operations in their totality. Like a ship captain unrolling a map detailing every nuance of the voyage, business leaders can use a digital operational basemap to set strategy based on a comprehensive picture of assets, people, and processes.

Map layers—managed by GIS technology—bring critical information to light. Using GIS, a business leader can view all the real estate a company owns; underutilized sites or resources that can be repurposed; factories with the greatest emissions reductions; or offices with the highest percentage of employees working remotely.

For ExxonMobil, one of the world's largest publicly traded international energy companies, an operational basemap was key to unlocking real estate insights that contributed to the company's bottom line. The results of this location awareness have provided better insights into how real estate contributes to building an advantaged portfolio. Real estate analysis that in some cases took 30 employees nearly eight months to perform is now completed in seconds, explains Joel Glaze, ExxonMobil's global real estate optimization lead.

An Operational Basemap Guides ExxonMobil's Real Estate Strategy

ExxonMobil and its affiliates own thousands of assets and land parcels around the world.

ExxonMobil Environmental and Property Solutions Company (E&PS) helps oversees the life cycle of its global real estate holdings, from construction planning to operations to divestment.

While the company had data on all these assets, the information lived in different areas of the organization. To speed up strategic decisions, E&PS created an operational basemap of all of ExxonMobil's landholdings, which can be updated in real time and shared across locations and time zones.

The Basemap as a Backbone of Smart Strategy

An operational basemap provides a competitive advantage to institutions large or small. A regional bank executive might use a digital basemap to visualize data about customers' technology preferences before deploying digitally enhanced ATMs.

For a broadband provider that's grown through acquisitions, a GIS-powered basemap can track coaxial and fiber networks and help salespeople advise prospective customers on service availability.

With the enterprise awareness supplied by an operational basemap, executives across a broad range of industries can plan with the big picture in mind—not just a piece of it.

For a deeper look at how ExxonMobil benefits from its operational basemap, view the full video.

Advising an Industry in Transition

As consumers change everything from how they spend money to where they deposit it, an old law of banking—build a branch and they will come—is breaking down. In a sign of the shifting times, over 40 percent of core retail banking sales in 2021 were digital in nature, according to a McKinsey survey. To cope, financial institutions (FIs) are deploying advanced ATMs, self-service banking kiosks, and online services.

Many FIs are turning to consultants to analyze banking preferences in specific markets and determine the best mix of touchpoints for clients' needs. Longtime ATM manufacturer Diebold Nixdorf has parlayed years of experience with FIs into an Advisory Services group that guides branch transformations.

Diebold Nixdorf advisers use GIS technology to analyze local financial habits and shape the bank networks of tomorrow.

"We get really granular on our recommendations, and the deeper we get, the more we use the spatial component," says Scott Weston, global adviser for banking channel transformation at Diebold Nixdorf.

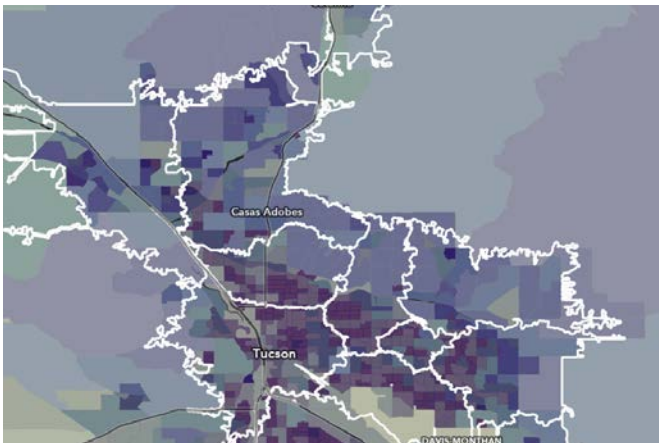
By analyzing demographics, technology preferences, bank transactions, real estate data, retail indicators, and other metrics, Diebold Nixdorf consultants help FI leaders reimagine expansion or consolidation plans, sometimes in surprising ways.

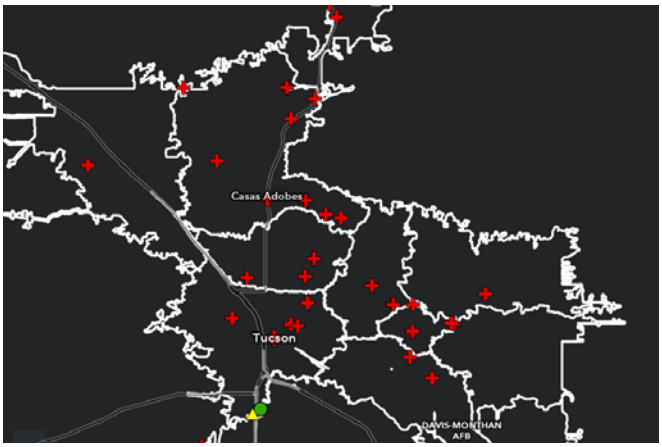
"Location and what you're trying to do strategically becomes very, very important to help drive revenue and do it efficiently," says Simon Powley, head of Diebold Nixdorf's Advisory Services team.

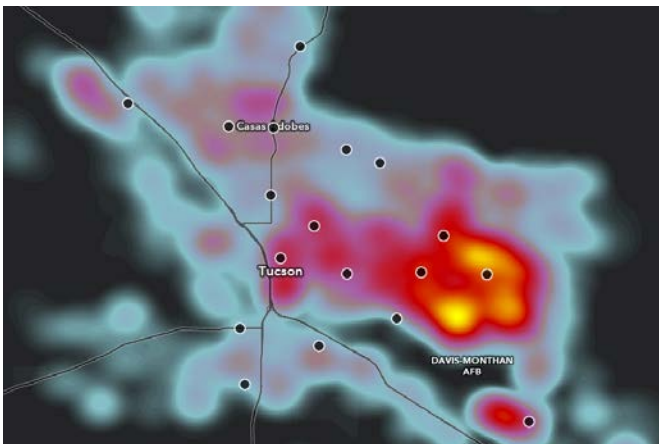
A Location-Based Approach to Banking Optimization

Building a new bank branch can be a multimillion-dollar proposition. Location analytics might reveal that a strategically deployed mix of ATMs could accomplish the same goal for a much smaller price tag. If a new branch location is the most effective move, Diebold Nixdorf's Advisory Services staff can steer banking executives to neighborhoods that will be the best fit based on population, age, spending, and other factors.

> "For the C-suite, I would say a map or a visual piece is 10 times more important than a PowerPoint slide with words on it, because they want to see and feel and touch it, and it becomes real life to them."
>
> -Simon Powley, Diebold Nixdorf







"They picked towns within counties that would be in line with what our long-term strategic plan is," says Jackie Hoonjan, president and CEO of Pacific Cascade Credit Union, a client of Diebold Nixdorf's based in Eugene, Oregon.

Using location analysis, the consultants recommended nine towns where new branches or ATMs could help Pacific Cascade reach members. Seeing the data on maps helped win over the company's board of directors.

"We were kind of wowed with the numbers that they gave us, with the details that they gave us," Hoonjan says.

The Diebold Nixdorf team recently worked with a financial institution in Jacksonville, Florida, that was planning branches to fill gaps in market coverage. Weston's GIS analysis indicated that adding 15 to 20 off-premises ATMs could cover 85 percent of area households, while bolstering the FI's visibility in the area.

"By leveraging this kind of mapping technology, we can help [FIs] decide the best place to run a pilot or where you are going to be more successful," Powley says. "We're not a one-size-fits-all shop. And that's where our analysis and data capabilities really come into place."

Right Number, Right Location, Right Technology

When Weston, fellow consultant Marilyn Howe, and their Advisory Services colleagues analyze data to optimize a branch and ATM network, they're looking at the interplay of three factors: the right number of touchpoints, the right locations, and the technological proficiency of users in the area.

> "In the organizations we work with, I'm seeing that C-level leaders really find value in the complex data analysis we provide. Many of them have never had a GIS specialist on their team providing the spatial perspective."
>
> -Marilyn Howe, Diebold Nixdorf

"We are looking to understand how customers are leveraging various channels and what that tells us about their preferred engagement with their financial institution," says Howe, a senior manager in Advisory Services. "We're always looking at consumer behaviors through the technology-usage lens, which is different from the traditional consulting perspective."

To determine the best locations, Howe and other Diebold Nixdorf consultants use GIS to analyze banking and shopping activity across neighborhoods. A hot spot analysis might highlight areas with high or low deposits. Metrics like borrowing capacity and spending enhance the view.

Finally, Diebold Nixdorf advisers add data that reveals local consumer comfort with online banking or ATMs. "We'll use consumer insight surveys blended with demographic data to understand pockets of opportunity within the market," Howe explains.

In the case of Pacific Cascade Credit Union, Diebold Nixdorf's analysis helped Hoonjan push past generalizations. In Roseburg, Oregon, where the CEO is finalizing on one of the suggested properties, Howe found that 40 percent of members were younger individuals and families, suggesting a familiarity with technology. But Hoonjan has also found that young people still enjoy the human touch of a physical bank. Location analysis can help leaders fine-tune decisions that strike the right balance.

"The research part of it was showing [that] with all the statistics and the demographics of that area . . . we would pick up the membership that falls in line with what Pacific Cascade is all about," Hoonjan says.

A Granular View of Banking Markets

Rather than relying on general market trends, Diebold Nixdorf advisers like Howe and Weston root their recommendations in a bank's own data—and the results can sometimes come as a surprise.

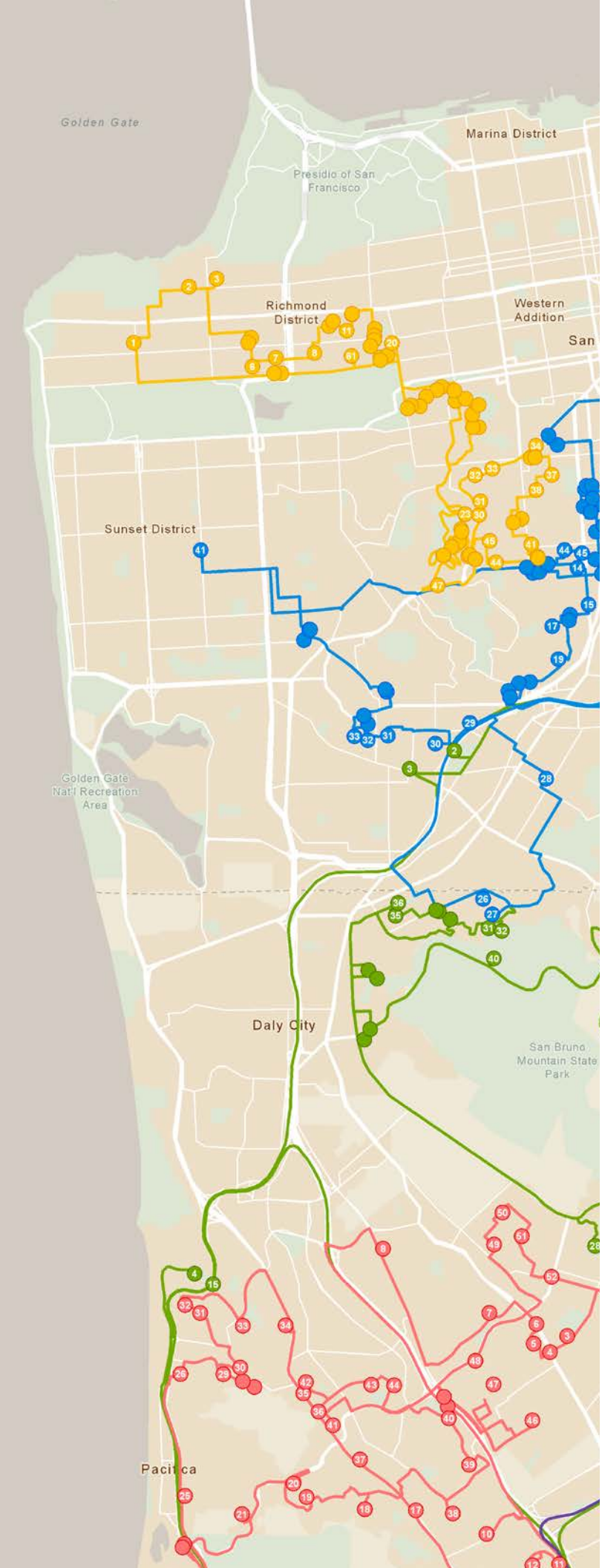
One credit union in San Jose, California, wanted to identify which members might be at risk for attrition as the firm looked to consolidate branches. The organization's leaders, who expected to lose hundreds or even thousands of clients, were shocked at Diebold Nixdorf's GIS-backed projection that only 80 or 90 members might be at high risk of attrition at one location. In the end, the results confirmed the GIS analysis.

When trends like branch transformation disrupt industry norms, executives need guidance tailored to their unique markets, clientele, and strategic goals. Diebold Nixdorf's approach, informed by location analytics, reflects the reality that not all customers are the same, nor do they all want to bank in the same way. Taking a geographic approach to data is one key to that granular view.

> "If you think about what we do, we can't do this without a GIS. It's just not possible."
>
> -Scott Weston, Diebold Nixdorf

Market Planning and Development

At market-leading organizations worldwide, executives are growing the business through a spatial understanding of customers, markets, and communities. GIS fuels that understanding with insight on where the business stands in the marketplace and how executives should plan the next phase of growth.



Market Planning and Development (continued)

Most business leaders have a gut feeling about who their customers are, but data can tell a different story. With GIS, assumptions yield to spatial analysis, and a company's top consumers reveal themselves in precise, anonymous demographic and psychographic detail. It's a feat of business intelligence only location software can accomplish.

Behind every Fortune 500 company is the story of modest roots and impressive growth. Dig deeper and you're likely to hear a tale of location analysis. Consider OXXO, a Mexico-based convenience store operator with 23,000 locations. With an unwavering business vision and location intelligence from GIS technology, the company consistently adds over 1,000 stores each year, and is introducing its brand to markets in Brazil, Chile, Colombia, and Peru. It's an expansion story made possible by spatial thinking and pinpoint market analysis.

At the world's second-largest commercial real estate firm by revenue, market planning and development are foundational capabilities, and GIS helps power both. JLL has delivered reliable insight to clients for hundreds of years, and does so at scale, generating market intelligence accessible to thousands of employees. If a client is considering expansion, JLL brokers can create a GIS dashboard of population growth trends in several candidate cities—then deepen the analysis with demographics and labor data. It's all in a day's work for a location expert like JLL.

For Penske's Kwaku Baa, GIS technology emerged as a tool of insight during the COVID-19 pandemic. With maps and data, he kept executives apprised of the state of the business—critical context during a time of upheaval. Since then, GIS has become a go-to tool across the enterprise, helping Penske optimize its service network and spot new areas of customer demand.

For expanding businesses, few things matter more than understanding market dynamics and selecting optimal locations. Without spatial analysis, companies risk investing in sites destined to underperform—essentially navigating growth blindfolded.

Finding the Confidence to Grow a Business

When a company is looking for new customers, its executives have two basic choices: Find new prospects within the existing footprint or forge a path into new markets. The latter is often more daunting, since deciding which markets to enter is fraught with risk. Executives of an earlier generation used to make these decisions with a greater margin for error. But profits are thinner now, and the competition both bolder and faster. As a result, market intelligence must be ever more precise.

Companies are now using new forms of data and analysis—and, in some cases, artificial intelligence (AI)—to bolster confidence as they enter new markets. Retailers, banks, restaurants, and consumer packaged goods companies are analyzing location-specific data to get a detailed read on each new market. These businesses are gauging how a market's demographics, psychographics, and economic trends complement their mission.

Selecting a new market based on location intelligence is a form of data-driven decision-making. Gartner research vice president Mike Rollings recently wrote about the need for data and analytics to take center stage in the digital age, as opposed to playing a supporting role. Forrester weighed in as well, saying companies that leverage data-driven decisions to uncover competitive advantage grow an average of more than 30 percent annually.

Leading companies that face the all-important question of where to go next are using location intelligence to vet potential markets. The primary engine of that intelligence is a planning tool called a geographic information system (GIS), which maps the location of—and relationships between—consumer trends, spending patterns, and other data in potential markets. The upshot: These global executives are basing decisions on insights-driven data rather than supposition.

Improving the Odds of Market Success

Traditionally, a retailer might plan to move into three new markets knowing that one might thrive, the second might perform adequately, and the third might fail. Today, every business that wants to grow needs to be much more precise. Making the wrong choice carries a double penalty–the investment lost due to entering the wrong market and the opportunity cost of not choosing the right market.

Savvy executives are using data analytics to remove guesswork, with tools such as GIS that steer them to markets most likely to favor success. According to the *Harvard Business Review*, GIS-powered mapping allows analysis of information from a wide variety of public and private sources–including demographic data and physical markers such as post offices, banks, schools, and hospitals–layered with data on the values, attitudes, and behaviors of different groups. Taken together, this granular information forms a reliable vision of opportunity, giving executives confidence to execute growth plans.

OXXO's Formula for Expansion Success

Mexican convenience store chain OXXO is using GIS technology to propel its remarkable growth plans. The chain now has more than 23,000 stores and is on a consistent pace of over 1,000 openings annually, with significant potential for further acquisitions in coming years. OXXO plans to nearly double its store count in the years ahead, according to Enrique Espinosa, an expansion manager at the company. To reach that growth target, OXXO is setting its sights on untapped South American markets in Peru, Chile, Colombia, and Brazil.

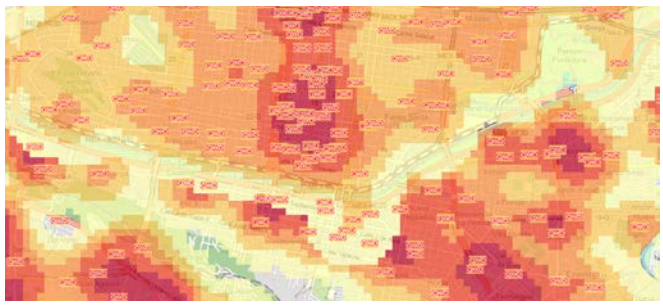
The company's challenge is to understand local needs and business conditions in these four countries where it has never done business. Though there are many similarities between Mexico and the new markets, there are also major differences.

"People are people here in Mexico or in Chile, so we both eat at certain times and leave work at about the same times," Espinosa says. When someone is on their way back home, for example, OXXO has the opportunity to provide whatever they need at the moment, whether that be a quick snack on the way to an evening activity or final items on the list for tonight's dinner. OXXO stores come in three varieties–small convenience stores for on-the-go purchases, larger outlets akin to grocery stores, and locations that combine both formats. All stores handle financial transactions such as bill payments, money transfers, and replenishment of calling cards.

When expanding to its South American target countries, OXXO will have to adjust its approach. For instance, the company will not be able to use "mirror" stores, a common technique for plotting new locations in Mexico. With the mirror technique, OXXO identifies traits associated with successful stores–including demographics of local people and traffic flows. GIS then reveals locations that mirror those characteristics in other geographies. In new target markets, however, there are no existing stores to mirror.

That means the team needs other forms of location intelligence to build its confidence. GIS acts as the engine of that insight, empowering the team to map population densities, traffic patterns, the rate of local car ownership, and shifts in demographics in the new markets. GIS will also help them identify what Espinosa calls "generators of activity" such as banks, schools, and malls.

With that location intelligence, OXXO executives will find the confidence they need to make significant investments in growth.



Spotting Potential and Driving Success

Some companies are going beyond assessing existing conditions in markets they plan to enter. They are predicting how those conditions will change and how the company can harness—even drive—those changes in certain locations. Case in point: A major global brewing company is expanding from distributing its product to retailers and restaurants to operating its own brew pubs in several major cities in multiple countries. It needs local insight to gain confidence that it has the right strategy for each local market it will enter.

The brewing company is betting its brand is strong enough to go into a community that's not necessarily a hot spot and actually make it trendy in a few years. That's not bluster; it's confidence derived from location intelligence. Using GIS, the company can see the popularity of craft beers within specific neighborhoods. Its planners can examine nighttime human movement patterns, along with demographics and data from other area eateries. They can also create projections for candidate locations that reveal how the local population is expected to grow, how income and demographics will shift, and what to expect in terms of food and beverage spending.

With that data, they can sketch out the neighborhood's earning potential in the near term and beyond. Based on what the GIS maps tell them, company executives are realizing where they should put new stakes in the ground.

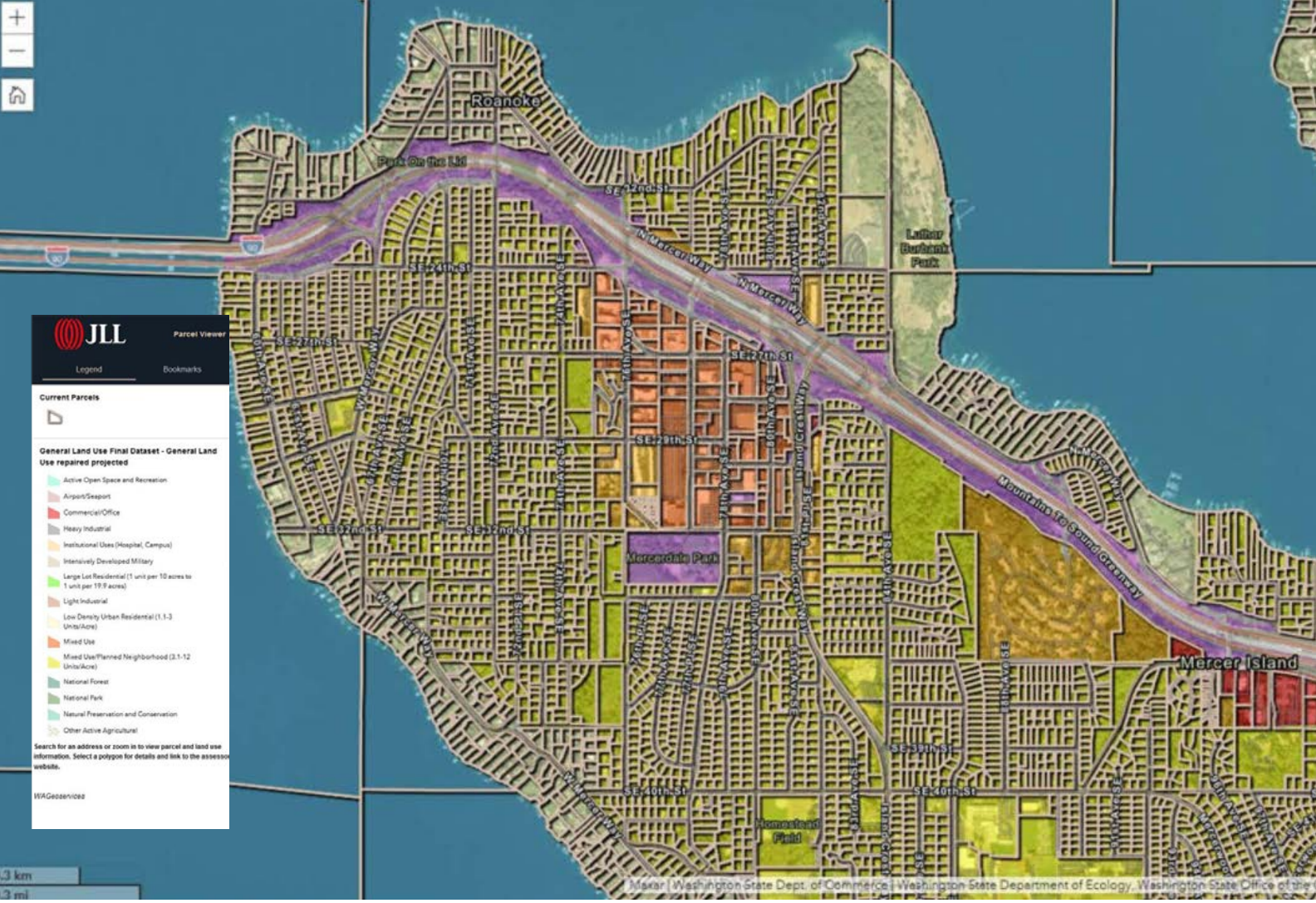
Gaining the Competitive Edge: How It Could Work

Beyond retail and restaurants, leaders in many other industries can boost confidence in growth plans with better location intelligence. Consider the hypothetical example of a solar panel distributor. After being fed satellite images of a prospective market, an AI-powered system could use image extraction and detection to classify how many rooftops it sees, how many of those face south, and whether each rooftop works well for solar panels. GIS can plot that analysis on a map, revealing areas of low, medium, and high market potential. The system could then cross-reference those findings with an analysis of demographics in that market—including household income and spending habits.

That data alone would provide a helpful starting point for the solar company, but it would not have to stop there. When deciding which markets to invest in, executives could take into account other factors revealed by GIS, including, for example, the presence of young residents who tend to buy "green" products, pegging them as more environmentally minded than the general public. Another important variable: areas where there's a high cost of energy. Mapping these different considerations might reveal a short list of potential sites, including those with a smaller population but higher overall potential.

The solar panel company could also compare its cost of service in different locations. This would include predicting what services, resources, and relationships with energy companies it would need to fulfill its obligation to customers. The promise is the ability to take all these variables and turn them into location intelligence. This knowledge could prove a powerful differentiator, giving the company a more reliable investment outlook as well as agility in a fast-paced environment.

As the *Harvard Business Review* underscores, the era of cost cutting has given way to recognition that growing a business is the only way to truly thrive. At the same time, companies can no longer afford to experiment with expansion plans. The days of selecting a new market based on assumptions and gut feeling are over. Advanced organizations are using GIS-powered location intelligence and AI to strengthen confidence in growth plans, analyzing a wide array of data sources to pinpoint locations that embody that elusive formula for success.



JLL Delivers Location Intelligence to Thousands of Employees

In the fiercely competitive $20 trillion world of commercial real estate (CRE), leadership demands continuous innovation to meet clients' changing needs.

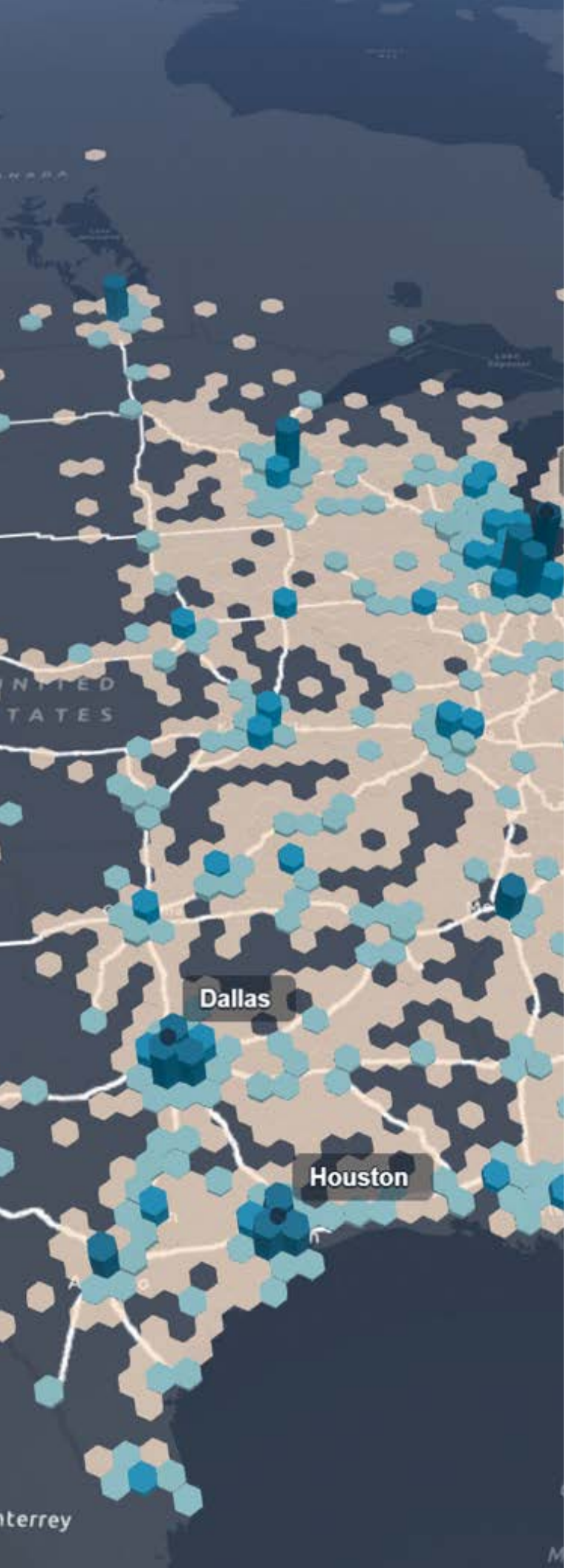
At JLL—the world's second-largest real estate brokerage by revenue—an innovative approach to data empowers the Fortune 200 company to address new client demands in an evolving economy. Today, JLL is as apt to advise the Department of Energy on solar power installations or partner with Bay Area Rapid Transit on a community-oriented headquarters as it is to lease office space.

Serving the real estate needs of clients across disparate sectors requires a keen sense of business advantages in specific locations throughout the world. To deliver this insight to clients, JLL professionals draw on deep industry experience, rich location data, and GIS technology.

Through self-serve or full-serve GIS, JLL analysts, brokers, and clients access data on consumer trends, demographics, labor availability, transportation routes, and other key location information to guide pivotal real estate decisions.

Combining GIS Expertise with Accessibility at JLL

More than 3,000 JLL leasing agents, brokers, capital markets analysts, valuation team members, and technical professionals use self-serve GIS to incorporate data-rich maps into client presentations and analyses.



"Within a few clicks and running a few processes, you can get into some really good, high-quality data," says global GIS manager Tyler Barras, who runs the self-service side of the house.

A broker coordinator, for instance, can easily create a detailed map for a building tour, with demographic layers that add context to the area of interest.

"It's growing all the time," Barras says of the company's self-service user base.

> Smart maps—dynamic maps a user can interact with—offer a powerful means to shape a company's strategy by displaying complex data in a compelling and digestible format.

JLL's full-serve GIS team acts as hands-on advisers, helping brokers harness location intelligence to serve clients. Managed by JLL's national director of GIS, Shannon Happ, the team supported more than 1,500 stakeholders in over 60 markets in 2022.

For instance, a Fortune 1000 company might request a demographic comparative analysis of several cities as it weighs where to expand. Happ's team can create a dashboard that displays population growth trends in those locations—then deepen the analysis by incorporating labor data. In a single, interactive view, the client sees labor pools, wage levels, competitors, and real estate options.

Through JLL's tiered approach to GIS, everyone in the company relies on one source of location data and accesses it in a way that best suits their role.

Maps Help Clients Justify Decisions with Data

Happ has been with the company since 2013, and Barras since 2016, but the drive to integrate GIS more comprehensively into the company's operations has accelerated in the last few years. The creation of JLL Technologies in 2019 signaled the company's determination to be a leader in the digital transformation of CRE.

"Our clients are getting smarter and expecting not just JLL but anybody in the industry to come with data to back up the recommendations we're making on their real estate," Happ says. "They want to be able to justify their real estate decisions based off of data."

Smart maps—dynamic maps a user can interact with—offer a powerful means to shape a company's strategy by displaying complex data in a compelling and easily digestible format.

"Most of our clients want to back up the decision, but not go through millions of lines of data in an Excel spreadsheet," Happ says. "GIS is a great way to visualize that data."

How JLL Structures GIS Teams for Success

Barras and Happ are frequent collaborators. While they share the same goal—empowering JLL professionals to solve client challenges and drive business growth with location intelligence—their teams are organized differently.

Happ oversees about 25 GIS analysts in JLL's research division, which assists brokers on client projects and business development. Some analysts are dedicated to primary markets like Los Angeles or New York. Others act as a "hub team," a quick-response unit that handles requests from brokers in smaller markets like Charlotte, North Carolina, that don't require a dedicated GIS professional.

Brokers' requests mirror the ever-changing landscape of CRE, responding, for instance, to the boom in e-commerce. The need for detailed accessibility studies to serve industrial clients has risen noticeably. Smart maps showing the location of intermodal facilities, rail lines, and highway access empower firms in their site-selection process, enabling them to reduce transportation costs and optimize shipping.

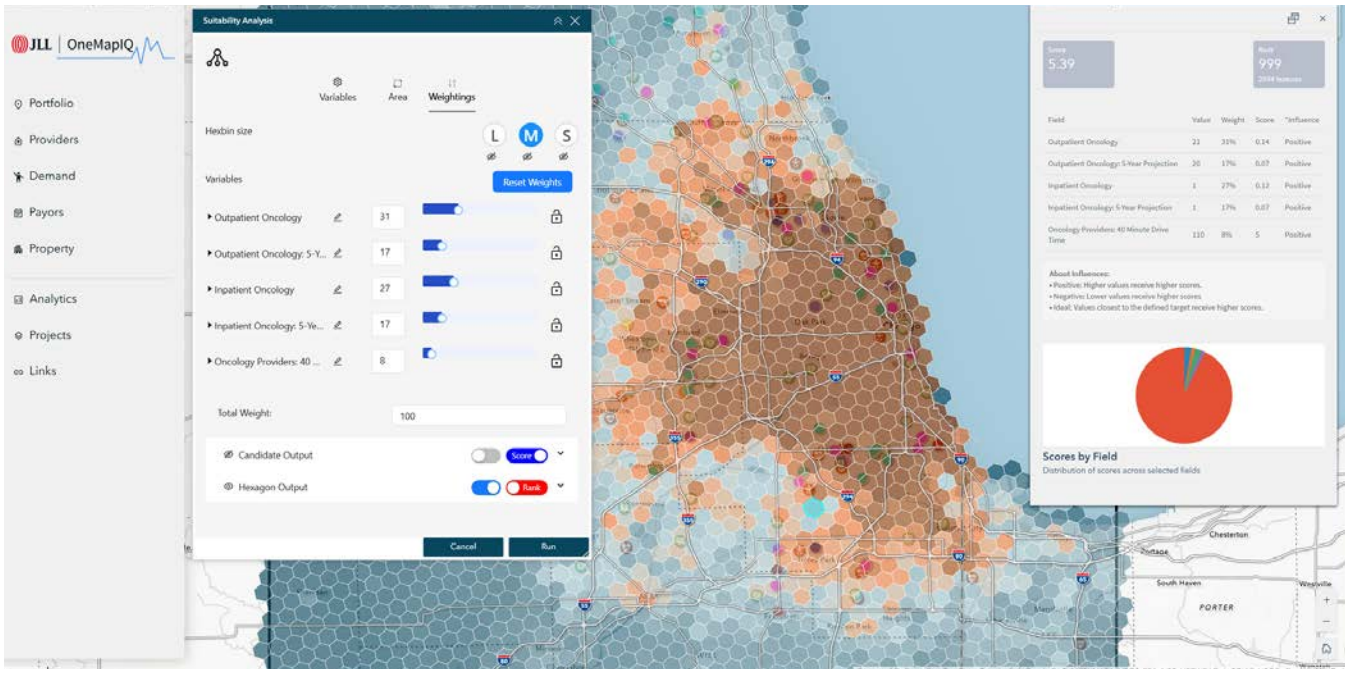
Happ's team often reads between the lines of client requests to deliver insight they may not have thought to ask for.

"I want my team to make sure they're … true advisers, not just behind the computer and creating maps," Happ says. "I want them to have a voice and talk about what the data visualizations are showing."

A Single Source of Truth

Barras combines a lean team with automated workflows and processes to serve JLL's major global markets, including the Americas; Europe, the Middle East, and Africa; and Asia Pacific.

In addition to helping JLL employees who don't have a GIS background create narrative maps and dashboards, Barras is also building out the technology's capacity to serve as a single source of truth throughout the



company. He maintains what is internally called the Geo Library—a curated source of location data that JLL employees can pull into maps and analyses, confident that it reflects the latest information on property types, demographics, and other market data.

"It just makes it so much easier for someone to find and access that data," Barras says of the technology. "The minute that someone makes a copy of it and uses it somewhere else, it's out-of-date. It's no longer connected to the source of truth."

At a company as large as JLL, getting everyone conversant in one technology is no simple feat. Through the ingenuity of self-service and full-service GIS, JLL has created a system of insight through which its professionals can advise clients worldwide.

"GIS is as much an art as a science," Happ says. "It's kind of limitless what we can do."

> "Most of our clients want to back up the decision, but not go through millions of lines of data in an Excel spreadsheet. GIS is a great way to visualize that data."
>
> - Shannon Happ, JLL

An Analytics Whiz Learns the Language of Business

Everything Kwaku Baa had studied—advanced math at a Ghanaian boarding school, engineering in Russia, computer programming and statistics in Toronto—should have prepared him for the project that landed on his desk that day.

He was a young programmer in the shipping department at Nortel, then one of Canada's most valuable companies and a standout in the 1990s tech boom. Baa's manager asked for a software program that would track shipments of Nortel's telecom equipment to customers worldwide.

Baa hesitated.

"I could write whatever code you asked me," he says now, "but I realized to be a good programmer, you have to understand . . . the different components of the businesses, how they all interact."

So Baa, who loved the vocabulary of calculus and the elegance of computer languages, enrolled in an MBA program to study the language of business.

What he learned was more than linguistics—it was an understanding of where value lies in a company, and how his work could expand across an enterprise.

Applying New Skills to Business Outcomes

Several years later in 2007, Baa was working full-time and studying for yet another degree—a master's in IT management at Carnegie Mellon—when he took an introductory class in GIS software. As the professor described the technology's capabilities, Baa's business sense began to tingle.

"I could see how GIS actually plays a huge part in what I was doing," he remembers.

At the time, he was working for a transportation company, mapping sales territories across the country. The data that determined where one manager's territory ended and another's began hinged on a matrix of calculations involving

drive times, competitor locations, fuel costs, and more. The team spent six months each year analyzing and structuring the territories.

Sensing an opportunity to improve the process and the bottom line, Baa began to experiment with GIS. Using the data science embedded in the software, he automated the analysis and mapping of sales territories. Soon, a six-month process had shrunk to barely 24 hours.

"We could just create scenarios in a day," Baa says of the GIS-based program. "It's all in bits and bytes, so you can just look at it and see whether you want it or not." If the management team didn't agree with a proposed map, "you send it back to my desk and I come up with a new solution."

Analytics Across the Enterprise

Hal Monty has worked with some of the sharpest minds in the business world—from fellow Six Sigma Master Black Belts at GE Aviation to investment managers in private equity—and he knows the rarity of someone like Kwaku Baa.

> "My approach is not about selling the use of GIS. It's all about understanding what is the business outcome you want to reach . . . and what has prevented you from getting there?"
>
> -Kwaku Baa, Penske

Baa and Monty have worked together for the last decade at Penske Truck Leasing—Monty as a consultant for market strategy and Baa as the company's director for customer experience and analytics. Penske leases more than 440,000 trucks—the literal engines of the economy—to commercial and retail customers in North America.

In Baa, Monty sees a passion for improving processes and wringing insight out of data. But first and foremost, he sees someone who is capable, impactful, and kind.

"I think his character shines through, and then the rest of the business acumen and stats skills just add to all of that," Monty says.

For Baa, the best insights often emerge from a marriage of data science and the data management and analysis facilitated by GIS technology.

"I started my career in classic analytics, using advanced statistical tools to solve business problems," he explains. "I consider GIS as a natural growth of the tools and capabilities we need to solve complex business problems that have location components."

When the pandemic hit, Baa and Monty began using GIS analysis to show Penske executives the daily state of the business. Data-rich maps revealed areas of risk exposure as well as opportunities for business growth. Once the COVID-19 wave receded, interest in GIS spread across the enterprise at Penske Truck Leasing, a company deeply rooted in innovation and analytics.

"Everybody who sees and hears about the GIS and what it can do wants a piece of it," Baa says.

Forget the Credit; Find the Solution

Baa grew up in Ghana, the youngest and quietest of eight siblings. He spent hours immersed in books and a small group of friends. He was driven to learn—an itch that propelled him to skip multiple grades during his K–12 education and eventually earn three postgraduate degrees. Just don't look for a string of letters after his name.

"He doesn't need to be the guy out front getting all the credit," says Samantha Thompson, head of customer success and fleet telematics at Penske Truck Leasing. "He's behind the scenes on a lot of major things happening here at Penske," she notes. "But he stands out."

> Using the data science embedded in GIS software, Kwaku Baa automated the analysis and mapping of Penske's sales territories, shrinking a six-month process to barely 24 hours.

Among other projects, Baa and the analytics team use GIS to address the same challenge he solved when he first discovered the technology years ago: planning sales territories for Penske's nearly 1,500 sites. With location intelligence from GIS, Penske optimizes its service network, spotting new areas of customer demand and ensuring that sales areas don't overlap.

> "We're always on the lookout for new things… And I see GIS as a new frontier for a lot of companies."
>
> -Kwaku Baa, Penske

Throughout the enterprise, Baa anticipates business needs and uses GIS technology to deliver more than colleagues expect. Recently, the facilities team requested a GIS dashboard showing basic attributes of work orders for Penske's leasing locations—information that would help them manage maintenance work on facilities. They hoped to update the data a few times a year.

Instead, Baa integrated GIS with Penske's asset management system, ensuring that up-to-date data flowed between the systems. His team added more information to the dashboard than the facilities team requested—not only details of each building's lighting system and driveway paving history, but its ownership and work order status, square footage, and more.

His advice to his team comes straight from his MBA days: "Let's understand their business goals beyond what they talk about. Let's give them something that's integrated into some of the tools that they have."

Location Intelligence, Analytics, and Dependability

Even as GIS spread across the Penske enterprise, Baa was surprised when members of corporate security and HR requested support. The analytics team is now working on ways in which location technology can monitor security across the company and analyze regional labor trends.

"My approach is not about selling the use of GIS," Baa says. He knows GIS technology and location analytics will help Penske address many business challenges, "but I don't go in saying that. It's all about understanding what is the business outcome you want to reach . . . and what has prevented you from getting there?"

In the months ahead, he expects GIS to expand even further across the enterprise. "I see it as a way to democratize information across Penske," he says.

That eagerness to support colleagues is a hallmark of the new business analyst, and Thompson sees it as one of Baa's best qualities.

"He is very willing to help people," she says, "and to help lift their work and move it forward with what he's capable of doing."

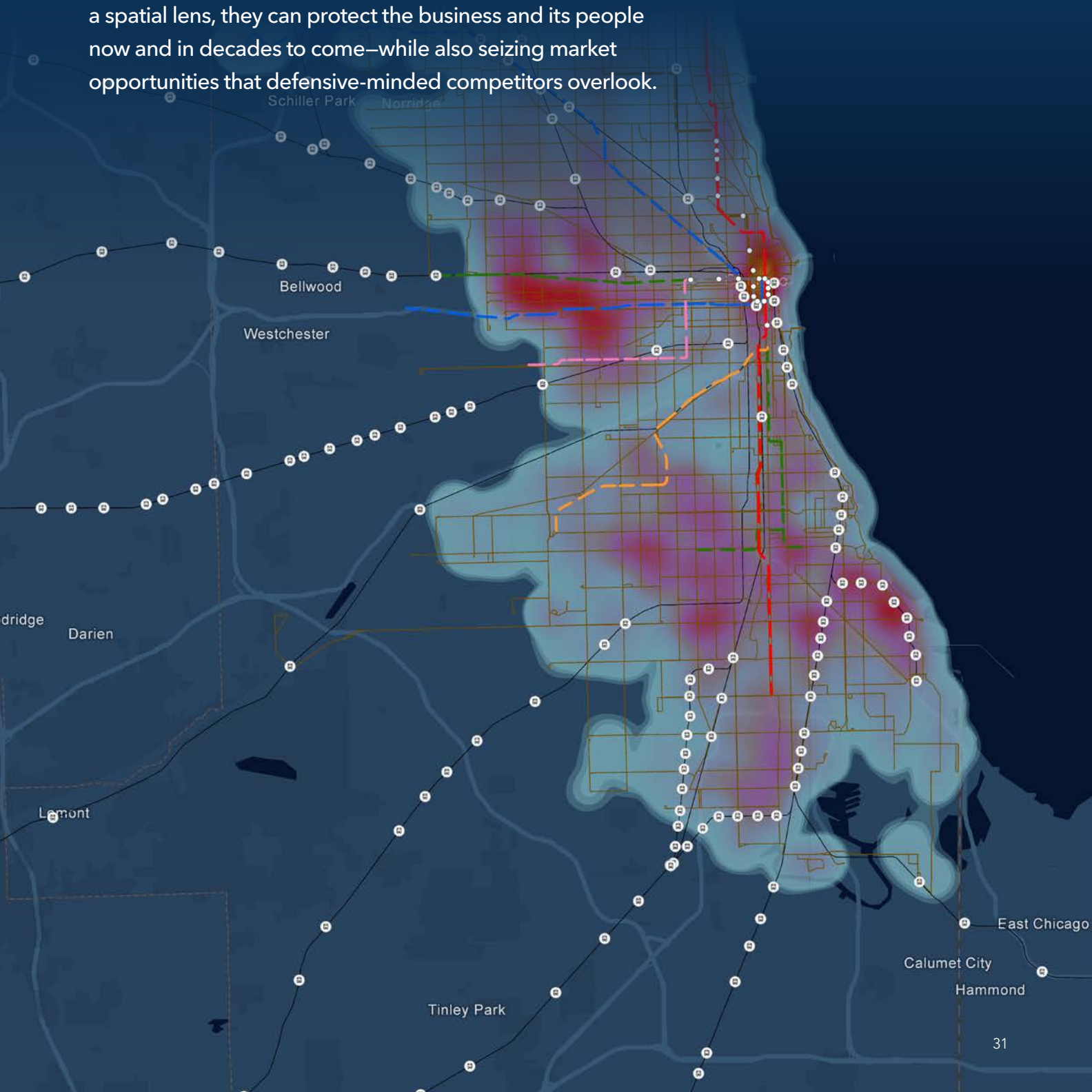
Monty agrees. On his list of Baa's most admirable qualities, GIS prowess and analytical savvy run a close second to dependability.

"If he commits to you, you can pretty much take it to the bank that he's going to follow through for you."

An analytics phenom realizes he lacks business awareness, signs on to earn an MBA, and goes on to deliver cutting-edge location analysis for transportation leader Penske.

Business Risk Analysis

To outpace competitors, today's business leaders must excel at analyzing the geography of risk. With reliable data and a spatial lens, they can protect the business and its people now and in decades to come—while also seizing market opportunities that defensive-minded competitors overlook.



Business Risk Analysis (continued)

The challenge is hard to overstate: Understanding the risk profile of even a single business location is growing more difficult as volatile weather and natural hazards proliferate. But assessing risk across hundreds or thousands of locations is beyond unwieldy; it's simply too complex for manual processing. It's also not the only challenge facing today's businesses. There are future risks to consider, too—the possibility that an asset considered safe today could be uninsurable two years or two decades from now.

Enter a triumvirate of tools: Real-time data provides the situational awareness a company needs to address disruptions. Spatial models anticipate future conditions for a given location, providing clarity for capital investments like stores, hotels, data centers, and infrastructure. And GIS technology puts it all on a map, contextualizing the risks to a business and illuminating mitigation options.

Marriott is using this trusted toolset to manage risk across its vast asset portfolio—nearly 9,500 properties in 144 countries. Every property's risk profile is intimately tied to its geography, making GIS maps a natural way to monitor them all.

The hotelier's global director of intelligence knows the importance of conveying risk data effectively. He calls the company's Risk Atlas a more digestible way of visualizing threat information than spreadsheets.

At one real estate investment firm in the Netherlands, location analysis is a core skill set. Bouwinvest had long been a seasoned GIS user, but as risk models for floods, storms, and excessive heat started to look increasingly perilous, analysts began creating maps showing the size of investments relative to their potential risk. The result was a much more strategic view of the business, allowing executives to make well-informed decisions on a property portfolio worth $17 billion.

Companies constantly evaluate where they should operate, and the US cities of Phoenix and Norfolk are using climate analysis and risk mitigation techniques to ensure they remain on executives' short lists. It's a new form of economic development, with GIS at its heart.

Leading global companies are using spatial analysis to democratize risk intelligence, empowering decision-makers with location insights that transform resilience from defense into competitive advantage.

Monitoring Risk at Marriott

In today's interconnected marketplace, many businesses need a centralized, systematic way to monitor risks across huge geographic areas and take action to mitigate impacts. Responding to hazards on an ad hoc basis isn't an option. For many organizations, a risk map has become the most effective way to monitor vulnerabilities around the globe.

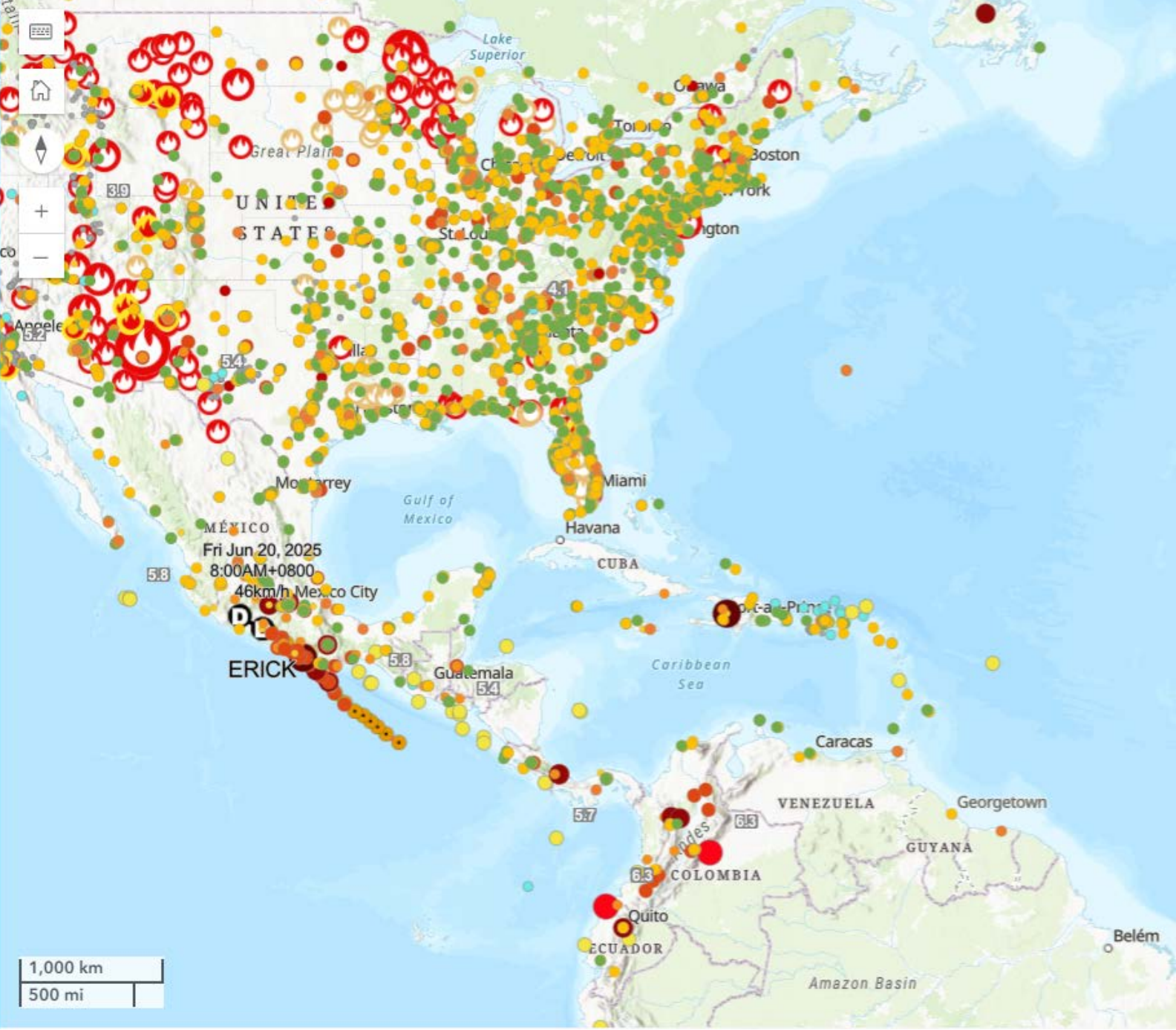
Built on GIS technology, risk maps can display all of a business's assets on a single dashboard, alongside threats by location. By toggling on data layers, executives gain a longer-term view, assessing climate risks, public health threats, crime trends, or geopolitical events.

At Marriott International, a hotel chain that encompasses nearly 9,500 properties across 144 countries, an in-house risk map called Risk Atlas has become a key tool for executives and decision-makers.

"In our line of work, people are kind of tired of looking at spreadsheets and white papers," says Morgan Dibble, Marriott's global intelligence director. "What we've created with Risk Atlas is a more interesting and digestible way of visualizing threat information."

Marriott's Unified Vision of Risk Management

Created by Dibble and his team, the Risk Atlas dashboard integrates GIS technology with a real-time alert monitoring service. By supplementing GIS data with social media alerts and news reports, the global intelligence team monitors developing trends and their potential impact on Marriott's business. These insights enable Dibble and team to assign risk scores to various regions and properties—a form of location intelligence that informs decisions on investments and site selection.



The map format also makes it easy to share data across the enterprise, from real estate teams to security managers.

The scale of Marriott International's business demands a two-pronged approach to managing risks. A global security operations center (GSOC)—an increasingly common department at large organizations—spearheads the real-time response to crises and emergencies.

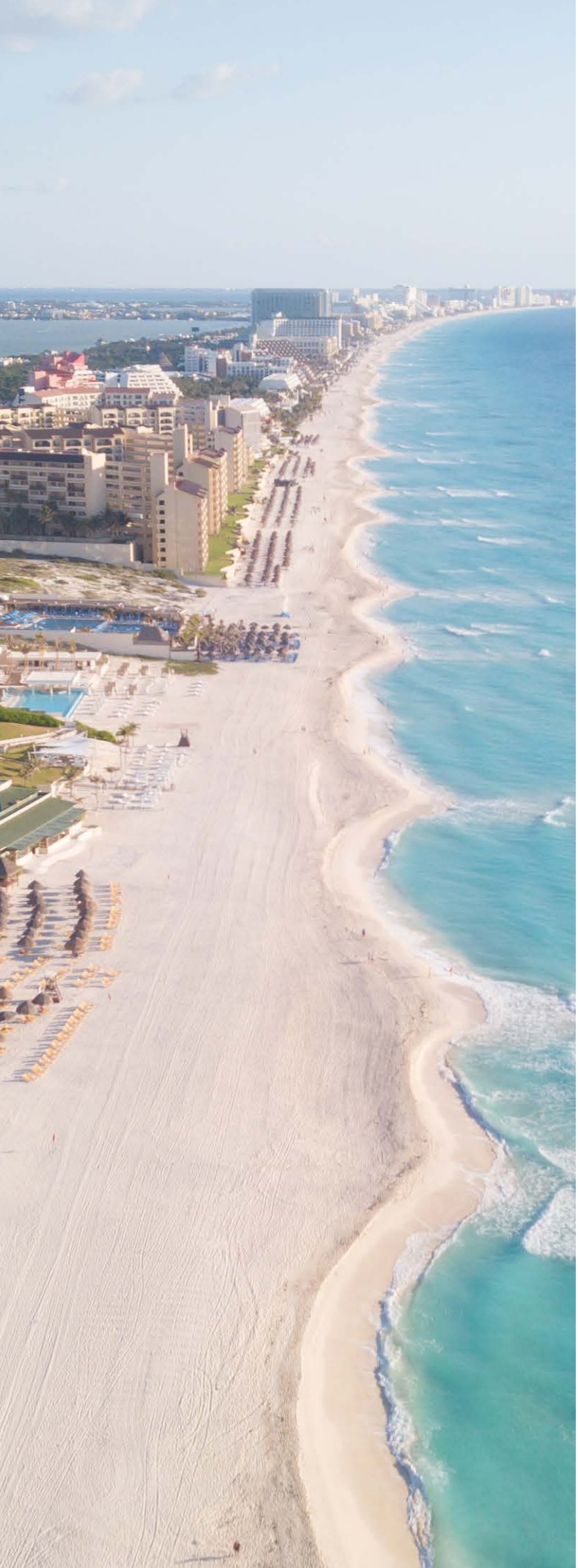
Dibble's global intelligence team takes a big-picture, strategic perspective, analyzing data to guide long-term decisions at the executive level and communicate with stakeholders.

"We can see our assets mapped globally, and then we can see the proximity to the alerts," Dibble explains.

Bringing Risk Monitoring In-House

Dibble found a surprising answer to the standard CIO question of whether he could integrate the technologies—GIS and the real-time alert service—without costly IT work. He simply created the integration himself using a standard API, despite having no coding background.

Through this simple integration, Dibble essentially built Risk Atlas from scratch, tailoring it to Marriott's



objectives and allowing it to adapt as new risks and new properties emerge.

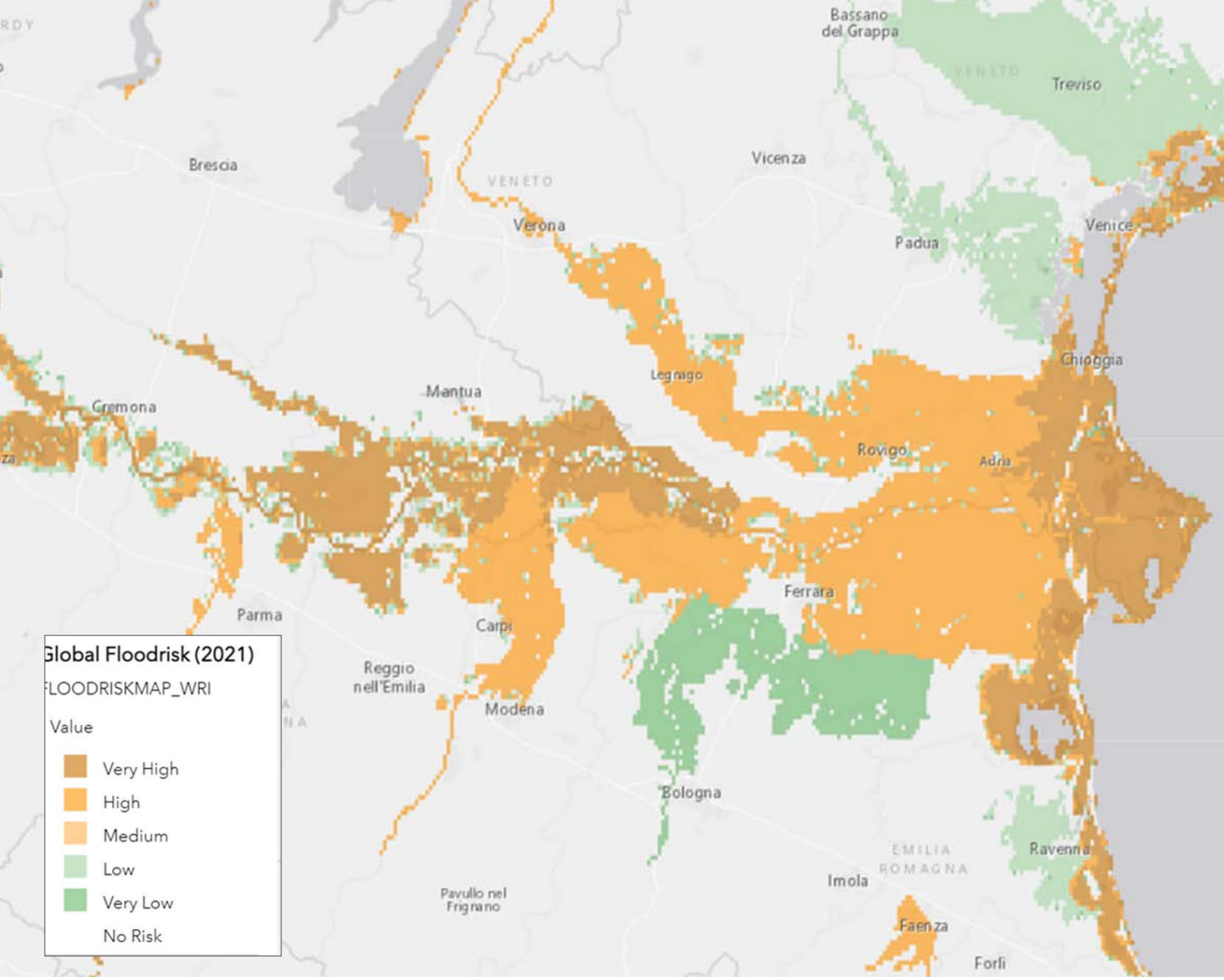
The ability to develop climate risk assessments in-house has proved to be a cost-effective alternative to hiring consultants. It can also mean a more reliable and up-to-date picture of operations. For instance, Dibble's team could pull in data from a newly released climate report and instantly interpret potential hazards for Marriott International locations. This information, in concert with real-time alerts about floods and storms, can inform investment decisions in regions where climate impacts are increasing.

With social unrest being a persistent global factor, hotel owners need to stay abreast of geopolitical tensions—an increasingly significant consideration for the industry, as predicted by a 2024 PwC hospitality report. A risk score for a country where political conflict is creating instability might affect Marriott's decision to build a new hotel there.

Hotels protect both guests and their own assets. With a GIS risk map and reliable alerts providing a comprehensive view of threats, hospitality executives can make the right decisions for their customers, their brand, and business continuity.

> With a simple integration of two forms of location intelligence, Marriott created a global view of risk and a barometer for key business decisions.

For a deeper look at how Marriott benefits from mapping and analytics, view the full video.



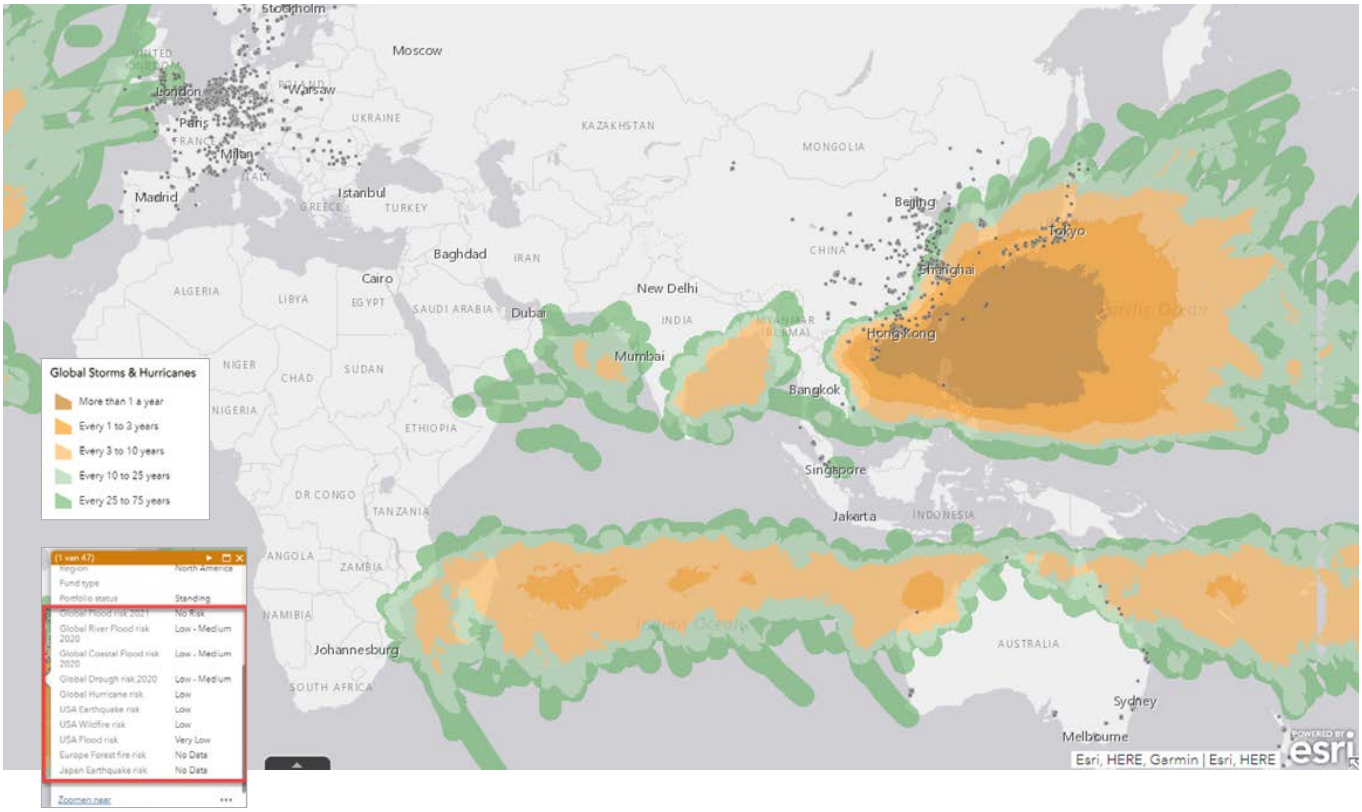
Bringing Climate Risk Assessments In-House with GIS

Executives today are taking the threat of climate change to business continuity more seriously than ever. In a 2022 Bloomberg survey, 85 percent of financial firms said they've started making climate risk assessments.

However, no two businesses face the same exposure to climate risks. The location and nature of operations shape a firm's unique vulnerabilities to environmental disruption. That has given rise to a cottage industry of consultants who tailor climate impact analysis to individual companies, but whose services can come at a steep cost.

For many businesses, a more direct solution can be found in software they already use: GIS technology. Bouwinvest, a major real estate investment firm based in the Netherlands, is among the companies using existing GIS capabilities to incorporate climate risk analysis into its investment strategy.

"I think a lot of our peers don't have the in-house knowledge of the climate maps," says Robert Wagenaar, Bouwinvest's head of portfolio operations and transactions. "We find it really important to have the in-house knowledge about how it works, and to be able to make our own analysis."



The Power of a Climate Risk Assessment Map

One of the largest real estate investors in the Netherlands, Bouwinvest oversees about $17 billion in property investments globally, with $11 billion of that in the Netherlands, where the company owns and operates residential buildings, office space, retail locations, and other real estate assets. Internationally, the company has $6 billion invested jointly with partners on the ground in Europe, North America, and Asia-Pacific.

Wagenaar advises decision-makers at Bouwinvest's investment offices in those regions, providing insight that includes climate risk assessments. To deliver these assessments, he relies on the location intelligence generated by the internal GIS team, composed of GIS administrator Rutger de Koning and GIS analyst Robert Mens.

> An inside look at how one global owner of office space, retail stores, and residential dwellings leveraged GIS analysts.

A climate risk map created by de Koning and Mens informs investment strategy by contextualizing threats and opportunities posed by flooding, heat stress, wildfires, and other environmental factors.

"By having the internal experts and the internal expertise, we as an investment team are discussing the climate scenarios, and the knowledge [of] the whole Bouwinvest team is getting better," Wagenaar told Esri's *WhereNext* magazine.

How Location Intelligence Leads to Better Risk Assessments

Bouwinvest's GIS climate dashboard pinpoints the location of the firm's investments around the world and indicates the relative size of each. A color-coding system expresses the severity of climate risk in each area. An investment manager can zoom out to see which regions the company is most heavily invested in, or where the biggest single investments are.

Alternately, by zooming in to a block-by-block view and toggling through climate-specific scenarios, decision-makers can see how individual properties might handle extreme precipitation or heat.

These insights inform discussions with building operators on mitigation measures—like raising

building foundations or installing green roofs—that can make the properties more resilient.

With spatial analysis from GIS, Mens and de Koning tailor data to answer specific questions from Wagenaar's team, allowing for more precise assessments. For instance, their experience with classifying climate data showed them that 20 centimeters—or just shy of eight inches—is a tipping point when it comes to property damage from waterlogging. Water levels below that mark are less of a concern while floods projected to surpass 20 centimeters represent a threat. Their climate risk map automatically incorporates such criteria, highlighting developments and properties that have a high risk of waterlogging.

"Because we have all the data in-house, we can also do the analyses relatively quickly," de Koning explains.

Balancing Gross Risk and Net Risk

Mens and de Koning carry out two main forms of analysis: climate risk assessments for buildings or portfolios under consideration for investment, and annual risk assessments for all of Bouwinvest's assets under management.

Which means that before they are data analysts, they are data wranglers. They pull a variety of sources into GIS, including:

> The Netherlands' one-stop shop for climate data, the GIS-powered Climate Impact Atlas, provides data on flooding, waterlogging, drought, and heat.

- The World Resources Institute, for aqueduct and drought data
- The National Oceanic and Atmospheric Administration, for hurricane data
- US Forest Service fire maps

For new investments, location intelligence helps quantify the gross risk of a geographic area and the net risk of a specific structure in that locale, based on any protective features it may have against environmental threats.

> "For the largest assets, we use the climate maps as a starting point for engagement with our local managers"
>
> -Robert Wagenaar, Bouwinvest.

This more granular assessment can help the firm see opportunities others don't. A town in northern Europe may show high risk of extreme heat. But Bouwinvest's local partners may note that residential developments there feature reflective roofs and heat-dampening window coatings. With that insight, investment managers can lower the risk profile of the portfolio and fine-tune their analysis on the likelihood of harmful heat effects.

With each annual climate risk assessment of Bouwinvest's holdings, the GIS team incorporates the latest and most detailed information available. For example, the World Resources Institute released a new coastal flooding map in 2022 with significantly more detail than the previous year's. Instead of engaging a consultant to make sense of the changes, de Koning and Mens used GIS to quickly reconcile the differences. Ultimately, they determined that only a fraction of European assets listed as high-risk in 2021 still carried that status.

A Spatial Basis for Decisions

Bouwinvest's climate risk assessments also help communicate insights across the organization, answering questions from pension fund board members or international fund managers.

"We need to be able to communicate instantly, to both our internal and external stakeholders, the impact of an event on our assets," Wagenaar says. "We quickly zoom in on the map and see: Where are the floodings and where are our assets? It's really easy to have those maps available all the time."

> "We need to be able to communicate instantly to [our stakeholders] the impact of an event on our assets. We quickly zoom in on the map and see: Where are the floodings and where are our assets?"
>
> -Robert Wagenaar, Bouwinvest

Such operational awareness is prized by global business leaders in sectors from retail to manufacturing to financial services, all of whom face an ever more volatile climate.

Wagenaar's team must account not only for present-day risks, but for climate trends that may develop in 10 or 20 years. The long-term view shapes the firm's own sustainability priorities, which include reducing energy use in its buildings to a third of current levels by 2045.

A More Resilient Business—and World

As Bouwinvest's leaders seek to standardize climate risk assessments across the international portfolio, GIS is playing an important role as a central platform for gathering and analyzing data and guiding action. Eventually, the international investment team would like to be able to assess not just how risky an investment is compared to a similar asset 10 miles away, but how it compares with an asset on another continent. Location intelligence helps create a common basis for evaluating risk in both hyperlocal and global contexts.

Through strong collaboration between Bouwinvest's investment strategy group and GIS team, the company is protecting shareholder value while raising the resiliency and climate awareness of the communities where they operate.

"I think we're trying, in our own small way, to make a difference and contribute to a sustainable society that we as a company are dedicated to," de Koning says.

Cities Prioritize Climate Resilience to Lure Businesses

Since this article was first published, Mark Hartman has retired as Phoenix's chief sustainability officer.

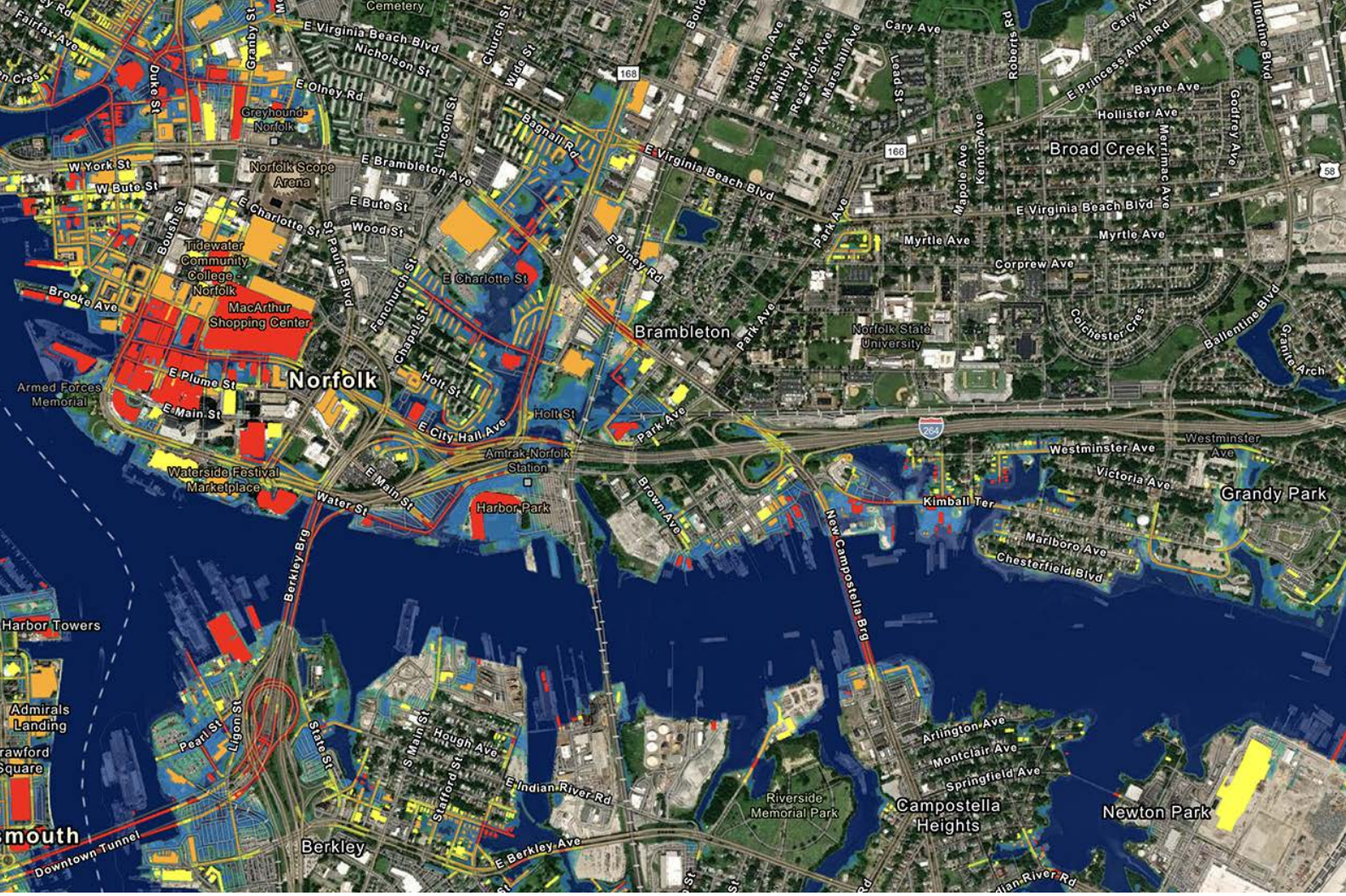
Watching Kyle Spencer scroll through digital maps of Norfolk, Virginia—where he serves as chief resilience officer—feels like a history lesson in the changing shape of a city defined by its relationship with water.

"Ten years ago . . . it was kind of taboo to talk about sea level rise," Spencer says from his home office. "Now, we are a resilient city, because we're not ignoring the problem. We're going to face it head on, and make it part of our identity."

That's a complex proposition for the nearly 250,000 people who call this coastal community home. Norfolk has long hosted the world's largest naval base; water itself drives employment here. But water also represents a threat to the city, which has the East Coast's highest rates of sea level rise.

Spencer and others in Norfolk are using location intelligence to shift the local narrative from one of climate challenge to opportunity. And they're not alone. Cities around the world are using location intelligence to build resilience by figuring out where climate risks are and where they will emerge, then creating smart maps to understand where adjustments can be made and what their impacts will be.

"Norfolk's been around for 400 years," Spencer says. "I feel like my job is to make sure we're around for another 400 years."



The Business Case for Climate-Resilient Cities

Climate resilience is increasingly viewed as a lever for a city's economic development. Traditional selling points, including low taxes, a strong workforce, and easy-access transportation, continue to play a role in the municipal incentive mix; but on their own, they're no longer enough to woo businesses.

That's because climate risks like sea level rise, expanded floodplains, wildfires, storms, and excessive heat threaten businesses' physical assets, employee safety, infrastructure services, and everything in between. Research shows that climate-related threats have the potential to drive a decrease in US GDP. As business leaders consider how to buffer their assets against climate change, they will look harder at the risk profiles and resilience of the cities they call home—or may call home in the future. Many of their stakeholders and partners are already doing so.

Insurers like Freddie Mac have long said climate risks could destroy billions of dollars' worth of property and displace millions of Americans. Now, real estate investors are echoing those concerns and factoring climate risk into decisions about where to invest. And companies like AT&T are using predictive location intelligence to anticipate climate risks decades in advance. City officials shouldn't be surprised to see similar caution among executives who plan restaurants, professional offices, big-box retail stores, and entertainment venues.

That's a compelling rallying cry for cities to shore up their efforts. More have been heeding the call over the last 10 years. In 2013, the Rockefeller Foundation created the 100 Resilient Cities network to foster collaboration among municipalities building resilience against physical, social, and economic challenges. Norfolk is among the 100, and Spencer says he's leveraging the network's insight to shape resilience.

Twenty-three hundred miles away, Phoenix, Arizona's chief sustainability officer Mark Hartman says his city is doing the same.

"To have a great quality of life for everyone while enhancing nature is the overall goal," he tells *WhereNext*. "Actually, that's what attracts business and people to move here. Businesses

look for sustainability and resilience in cities, so a lot of our pitch is how resilient we are."

While Norfolk works to stop or redirect the flow of water, Hartman's team is using location intelligence to redefine resilience in the country's hottest city. Extreme heat kills more Americans every year than all other weather-related hazards. Phoenix officials are using GIS technology to get a clearer view of where the city should step up efforts to mitigate high temperatures and improve water preservation.

A Tale of Two Cities and One Technology

Spencer and Hartman are leveraging smart maps to lay the groundwork for everything from seawall extensions that defend against the Atlantic Ocean to cool corridors created by tree plantings along Phoenix's hottest streets. "GIS—I think of it as the backbone of our resilience work," Spencer says.

He and others in the Norfolk region have created a network of flood and tide gauges that use GIS maps and dashboards to show water depth anywhere in the area, every hour of the day—a digital twin designed to monitor risk. On a micro level, it empowers a city worker to make real-time safety decisions. On a macro level, it helps Norfolk officials anticipate storm events and operationalize emergency services. Knowing more about the water's movement empowers city leaders to plan and build accordingly.

Now, Norfolk is in the design phase of a multimillion-dollar infrastructure project that employs GIS to model the way water moves through pipes coming inland from the river. With data from strategically placed sensors, officials can analyze the flow and build resilient infrastructure that creates the predictable conditions businesses need to invest.

Back in Phoenix, Hartman's team is using location intelligence to plan innovative ways of bolstering the city's resilience to high heat and low rainfall.

"Adversity is a midwife of resilience," Hartman says. "The fact that we've been 100 years in a desert environment means that we have adapted and learned, and that's our forte . . . We're working on a GIS-related plan to be heat ready."

Phoenix used smart mapping to identify areas where cool-pavement technology, or trees that create cool walking corridors, can deliver the biggest impact for residents and businesses. It's also using GIS to spot issues that can lead to water loss before it happens.

For example, a dedicated team within the municipal water department maintains smart maps that prioritize capital improvements to replace aging pipes and predict how much water a property will draw for landscaping. At the same time, a robust groundwater management plan has distinguished the city as a national leader in water recycling.

"In Phoenix, even with climate change impacts to renewable surface water supplies, we have enough water for 100 years and beyond," Hartman says.

Those efforts amplify Phoenix's draw as an energy-efficient city. They also allow the municipality to address climate resilience through the lens of social cohesion.

Climate Resilience as a Bridge to Inclusive Communities

"When you talk about resilience, it really is making sure everyone is resilient and looking at vulnerable populations," Hartman explains. "Because if we talk about a heat wave coming, it's actually the vulnerable populations who are most at risk. It's not the same risk for everyone."

Phoenix is working toward an overall tree canopy of 25 percent by 2030. Tree-lined streets cool down neighborhoods and lower the city's temperature. That helps homes and businesses cut back on energy use. It also promotes outdoor activities, including shopping, and makes it easier for residents to manage trips to work or school. But the tree canopy is much more limited in the city's low-income, heat-vulnerable neighborhoods.

So while the city's walkable urban code mandates 75 percent shade in new developments, Hartman

is looking to improve existing neighborhoods, creating smart maps that show heat indexes in areas where targeted tree planting can improve quality of life and a neighborhood's economic vibrance.

"If someone's transit dependent, they need to walk outdoors on the days that it's 120 degrees and find their way to the bus stops and navigate around the city," Hartman says. "We need to say, 'OK, if we're going to plant trees and create cool corridors, we need to do those in vulnerable neighborhoods.'"

Meanwhile, Norfolk is also using GIS-generated location intelligence to identify which residents are most vulnerable to climate change. Smart maps have empowered the city to prioritize floodwall extensions in the downtown core that will protect the public housing being built nearby. The maps reveal where flood protection will make the greatest difference.

Spencer and Hartman say maps help them explain resilience work to the city's stakeholders, including those in the corporate world.

"A lot of businesses are now starting to notice that we do have their best interests in mind," Hartman says. "We are going to try to take care of them the best we can. We're going to do our part, but we also have strong messaging around them doing their part."

Purpose-driven companies are growing three times faster than competitors and achieving higher employee and customer satisfaction, and they're likely to be drawn to cities that also prioritize climate action and resilience.

Spencer says, "We're winning large, hundred-million-dollar grants to do all this [resilience work], and we see the change in real life."

A Resilient Future Is a Collaborative Future

Building purpose-driven communities attractive to residents and sustainable for businesses in an age of climate risk will take strong teamwork.

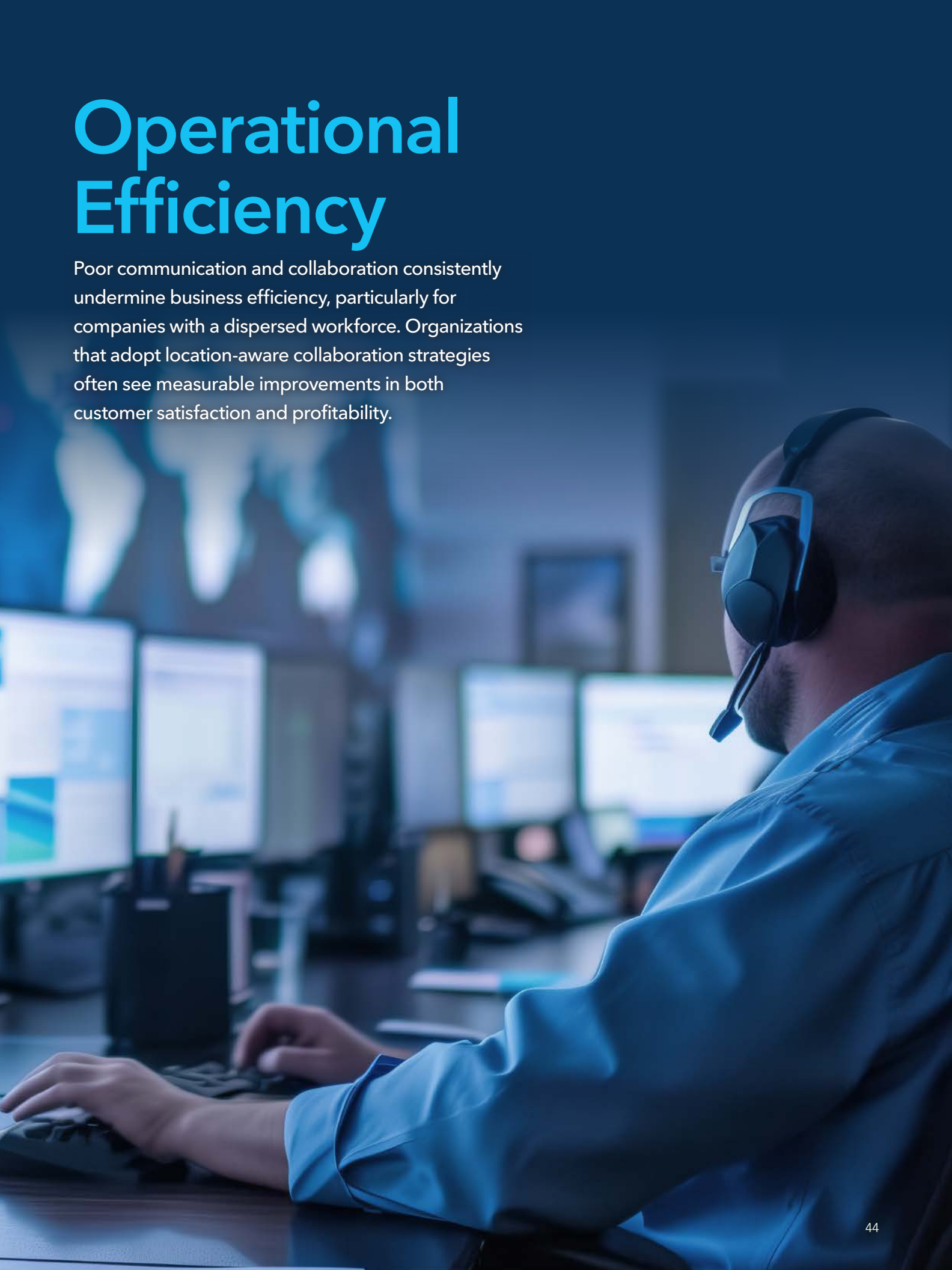
Norfolk and Phoenix have leaned on fellow city officials stateside and abroad since their earliest forays into resilience building. Cities have become increasingly open to sharing what they've tried, and what's worked well. That leads to solution leapfrogging and accelerates progress in locations around the world.

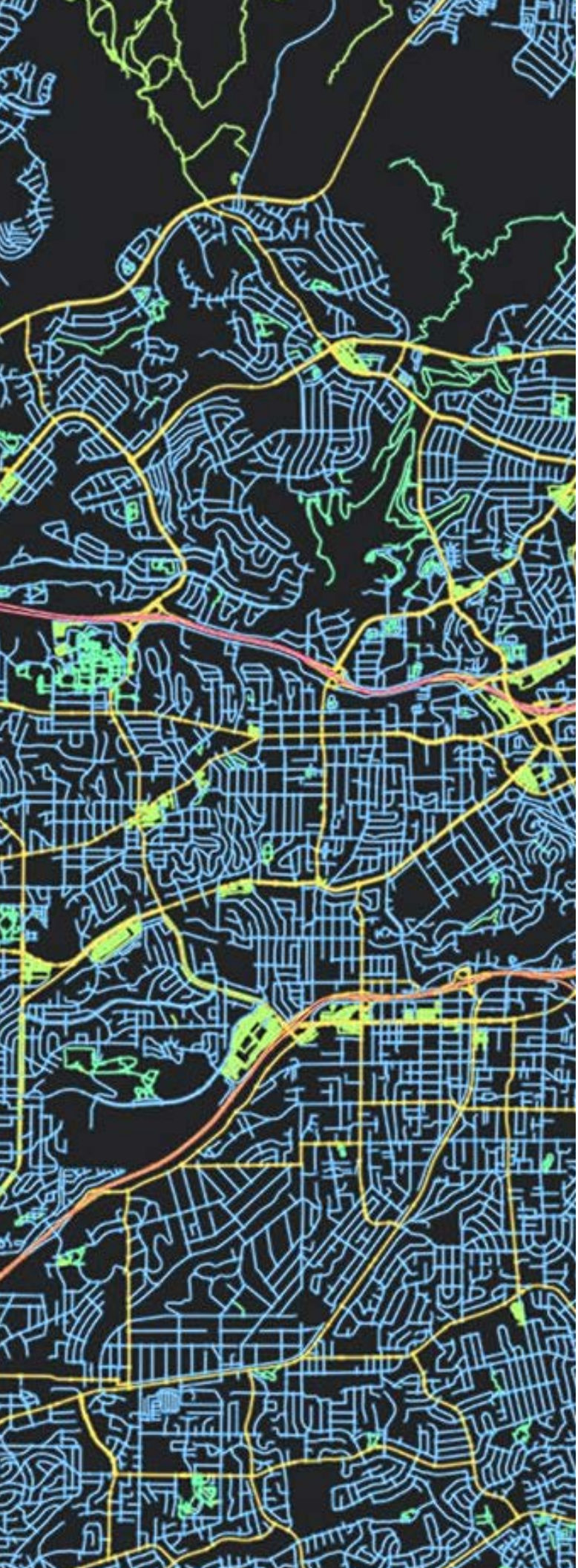
For Spencer and his floodplain maps, that means more families and businesses can exist in harmony with the water. For Hartman, it means using GIS to drive cooler conditions for Phoenix residents and businesses.

"I think people and businesses are looking from the outside in and [saying], 'They've got some problems, but they're working pretty hard to solve them, and I think they're going to,'" Spencer says.

Operational Efficiency

Poor communication and collaboration consistently undermine business efficiency, particularly for companies with a dispersed workforce. Organizations that adopt location-aware collaboration strategies often see measurable improvements in both customer satisfaction and profitability.





Operational Efficiency (continued)

In some cases, that means breaking down traditional data silos; in others, using maps as project management tools. In all cases, the desired outcomes are clear: delivering on the corporate mission, improving the bottom line, and maintaining customer satisfaction.

Imagine planning the daily routes of dozens or hundreds of service professionals—in this case, nurses and clinicians visiting multiple patients in their homes each day. The process quickly turned inefficient for one health-care company. GIS analysts and data scientists turned that around by rebalancing route efficiency, practitioner schedules, and patient preferences. The spatial overhaul saved clinicians more than 2,000 miles and 45 driving hours in just five months.

Similarly, broadband provider Fibrus improved its operational efficiency by putting GIS at the center of collaboration—inside and outside its four walls. The company tracks the progress of its network build-out on GIS maps—and pays suppliers based on their progress. If the work isn't in GIS—a single source of truth across the enterprise—it isn't billable. By eliminating data silos and redundant systems, the company made its production, billing, and communication faster and more effective.

For a globally dispersed firm like environmental consultant Bioinsight, distance was a barrier to efficiency. A team of Brazilian consultants might spend three days gathering sample data at a remote wind farm site, then return to São Paulo to manually send results to headquarters in Portugal. When the firm installed GIS apps on their mobile devices, the process became more collaborative and near real time, accelerating the firm's ability to deliver client results and receive timely payments.

In the perennial quest for operational efficiency, companies are learning how beneficial a well-architected, globally accessible location system can be to the bottom line.

Better Routing Leads to Better Health Care

For years, one health services company's team of nurse practitioners and physician assistants had been crisscrossing each other on highways and city streets. They were making home visits to members of a health program focused on providing preventive care. Nationwide, more than 1,000 practitioners carried out in-home medical exams for the plan's members, racking up millions of car miles a year en route.

The zigzagging was a drain on the team's efficiency. Clinicians found themselves bumping into one another in apartment building stairwells, having come from opposite ends of town to cover two different members in the same complex. Then they headed back out in opposite directions.

"The [clinicians] had often noted the challenges of passing each other during the day," explains the program's regional director of clinical operations.

The company faced a modern-day version of the classic traveling salesman problem: How does a business deliver services or goods across a geographic area as efficiently as possible? Multiply that question by the hundreds of thousands of member visits the program completed in 2020 alone, and it becomes both a burning issue to solve and a challenge ripe for location intelligence.

Route Optimization Could Improve Member, Employee Satisfaction

The routing challenges clinicians faced each day weren't just inconvenient, they were eating up valuable time. Nurse practitioners and physician assistants often felt rushed as they moved between appointments, and were limited in the number of cases they could cover in a typical 10-hour workday.

That's a familiar challenge for executives in sectors as diverse as retail, restaurants, home services, and logistics. Before the COVID-19 pandemic took hold, consumers were already embracing home

delivery in large numbers. In 2020, store closures and a stay-at-home mentality accelerated the shift, sending retail e-commerce sales up 28 percent.

Businesses that rely on location intelligence are positioned to thrive in this new reality. An IDC Canada survey showed that organizations with mature location analysis practices saw a 25 percent improvement across key business metrics over a two-year period. Whether a company is moving people, transporting goods, or providing services, the GIS technology that creates location intelligence is often at the heart of efficiency improvements.

At the health services company, the leadership team knew that smarter routing of home visits would do more than decrease costs. If done right, it could give clinicians more time with members, reduce cancellations, establish more predictable appointment times, and improve already strong member satisfaction scores.

The move could also have a positive effect on an employee's work-life balance. Well-trained clinicians were already in high demand before COVID-19. In fact, overall employment of nurse practitioners, anesthetists, and midwives has been projected to grow by 45 percent from 2019 to 2029. By creating better member and practitioner experiences, providers can cultivate a working environment that helps attract and retain top talent in tight markets.

The real question for company executives wasn't whether to create a more efficient network to support exceptional patient care and employee experiences, but how.

Using Data to Transform Human Experiences for the Better

For the health services company, the solution had to marry the right technology with an understanding of exactly what the program is designed to deliver: proactive, preventive health care for real people.

"We are not a delivery product," says the company's vice president of analytics. "We focus on human interactions, so the team studied how to improve logistics without compromising an exceptional member experience."

The result was a route optimization pilot program that the company rolled out in Texas in late summer 2019. Focused on the program's logistics strategy, the pilot aimed to improve both the bottom and—importantly—front lines for several dozen local clinicians and the members they serve.

> "We are not a delivery product. We focus on human interactions, so the team studied how to improve logistics without compromising an exceptional member experience."
>
> -VP, Analytics

Working together, the analytics and program teams developed a process to feed scheduling data into GIS route optimization algorithms, which generated the most efficient distribution of appointments and routes, including which clinicians should visit each member.

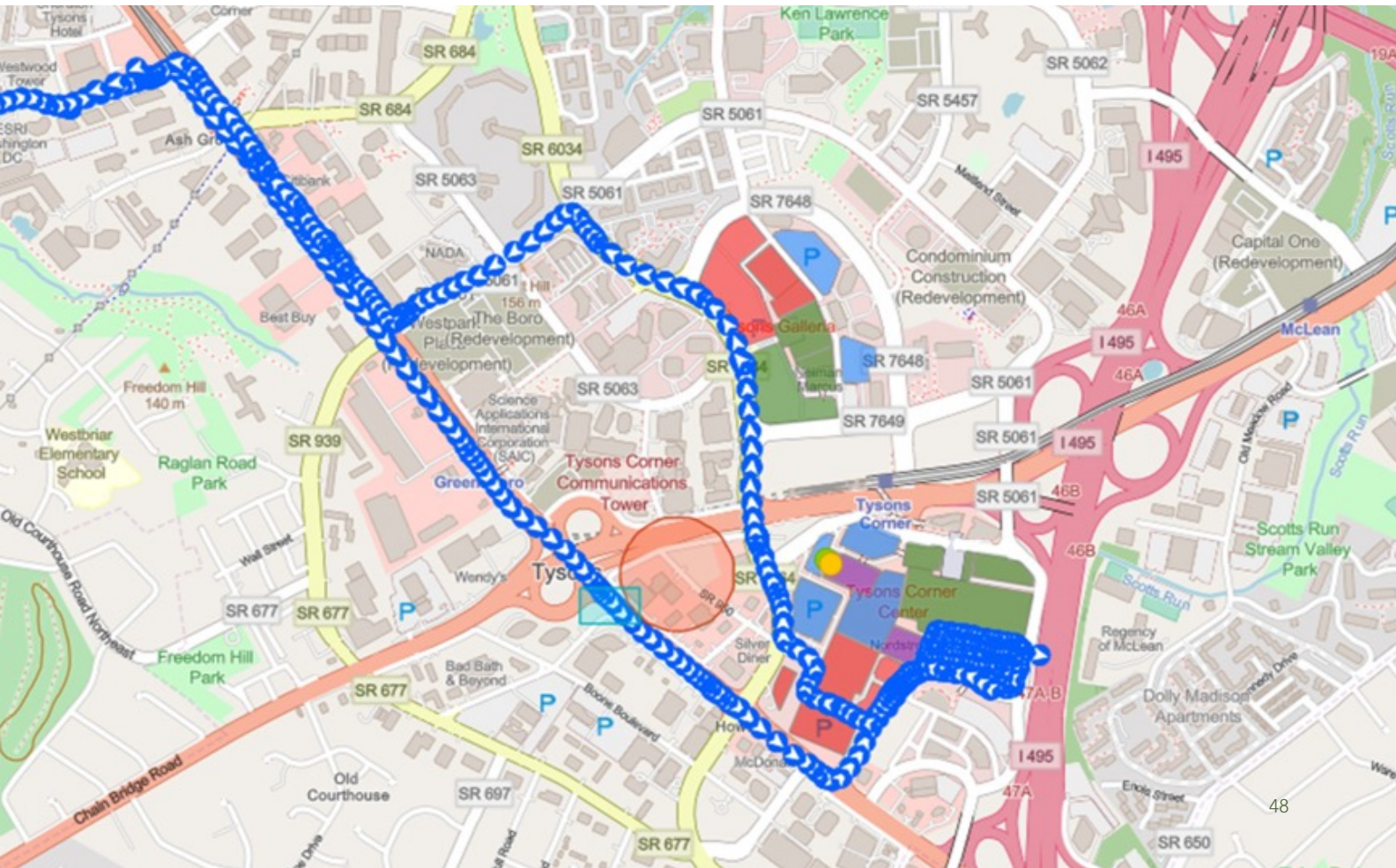
For the program's frontline workers, the impact was huge. Dispatchers sent optimized route plans to a clinician's tablet or smartphone, and the clinician benefited from the efficiency of smarter routes and shorter drive times.

Still, while GIS has excelled at planning everything from John Deere's dealer locations to maintenance work on FedEx planes, the home visits program had traits that traditional use cases did not. The team needed enough flexibility in its route optimization solution to satisfy all the nuances of member care.

Some members prefer either a male or female clinician. Others request the same clinician they saw last visit, or one who speaks a certain language. Those prerequisites culled about 25 percent of possible appointments from the pilot. The analytics team set to work using GIS algorithms to analyze the rest.

That required tweaks like holding off on announcing which nurse practitioner or physician assistant would cover an appointment until much closer to the date.

"This allowed the GIS algorithms to wait for all—or at least most—appointments to be scheduled before



committing the assigned APCs [advanced practice clinicians]," explains the analytics team's data scientist and GIS analyst. "That way the algorithms had as much information as possible on schedule adjustments and cancellations before making a decision."

During the pilot program, analysts manually verified the proposed routes to ensure that no patient preference, however subtle, was overlooked—a process that would eventually need to be automated in order to scale.

Starting Local, Thinking National, and Building Momentum

By February 2020, the route optimization pilot had helped program managers reassign more than 300 appointments along 200 routes, and the GIS-optimized schedules had saved clinicians over 2,000 miles and 45 driving hours in just five months. That amounted to a 10 percent decrease in drive time across the routes changed, and a 12 percent drop in drive distance—a substantial cost savings for the relatively small initial group.

The regional program director says that when routes are more efficient and days run smoother, clinicians provide an even higher level of service for a program that is already well regarded by members. When members can consistently rely on predicted arrival times and see their clinicians working without rushing, it makes a real difference in the member's day. It also empowers clinicians to focus not simply on making the appointment but making the most of it.

> "It was certainly exciting . . . creating a solution that our clinical team has been asking for, allowing us to serve our members better while helping our clinicians have more efficient days."
>
> -GIS Analyst

The nurse practitioners and physician assistants say shorter routes between visits allow them to repurpose saved minutes into member care, according to the director. "They can spend that time with our members ensuring a high-quality exam, teaching, and addressing any of the member's needs."

That supports a better working environment at a time when health-care professionals are stretched thin. In the director's words, the optimization program is a way "to help our employees have a better work-life balance and then give that time back to our members."

The results became a promising precursor to the company's next business challenge: How far could they extend those savings and improvements by applying GIS across thousands of clinicians, and millions of appointments, nationwide?

As the Pilot Proved Itself, the World Shifted Gears

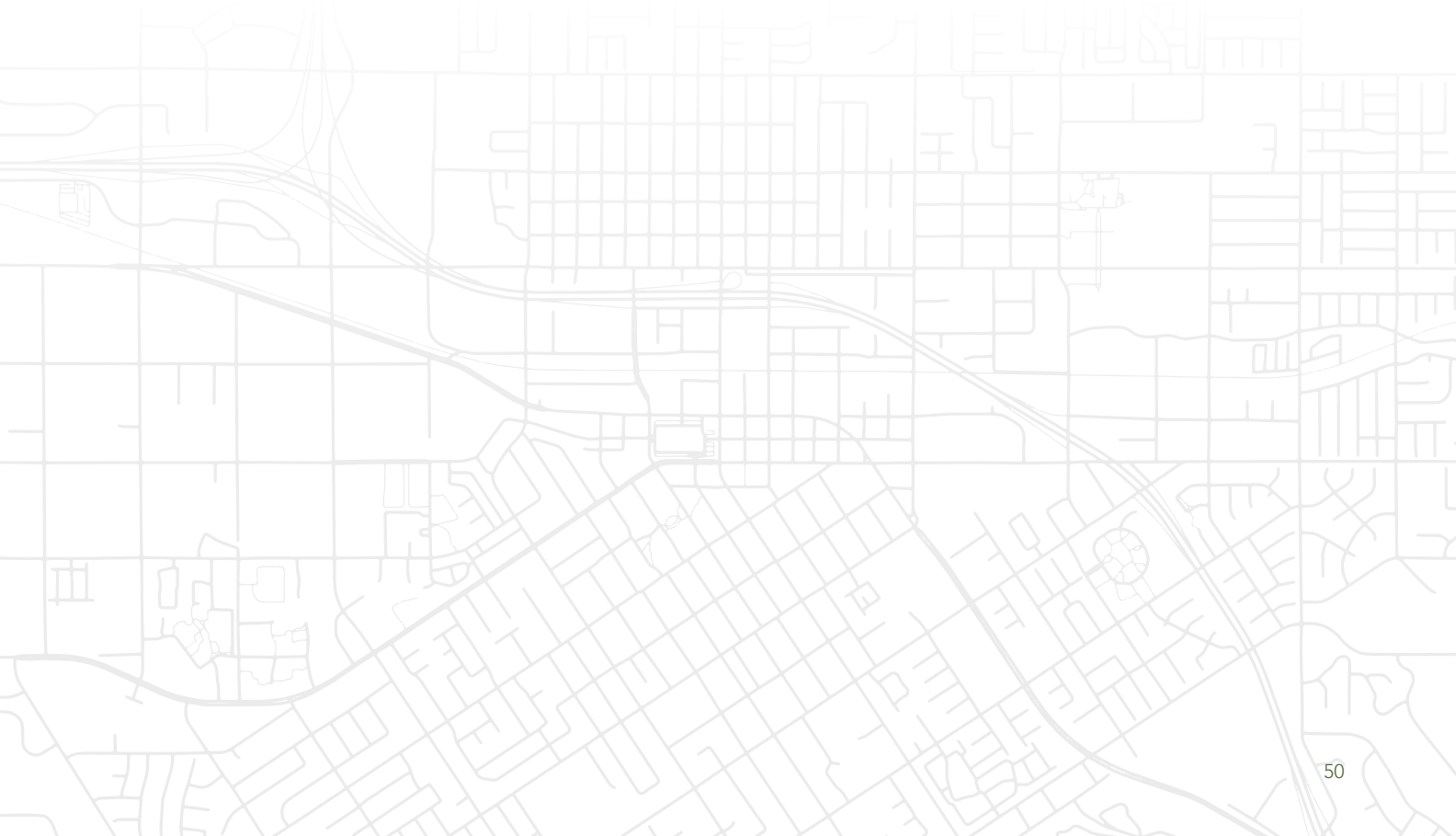
Buoyed by the pilot's progress, the company was poised to expand the program nationally. Then the world ground to a halt. The company primarily serves Medicare members, and their age made them particularly vulnerable to COVID-19. In deference to safety protocols, program directors temporarily prioritized virtual appointments over in-home visits.

The analytics team used the time to study the results from the pilot stage and ensure they were ready to expand GIS route optimization across the program nationally, which they did in Q4 of 2020. The analytics VP says they're now well positioned to tackle what many call a care gap that's widening under the weight of a strained health-care system.

The team has created processes that will make GIS-optimized routes feasible on a much larger scale. And they're incorporating stakeholder feedback every step of the way. Most importantly, they're working to keep their members and clinicians at the heart of the location intelligence solution.

"This program has been proven to reduce hospitalizations and increase visits to the primary care provider, closing the loop to ensure once we leave, that journey continues on to that healthier life," the regional director says. "Being out there in the home is really important and relevant right now."

And it's likely to become even more relevant as the company expands its use of location intelligence to support ever higher levels of member care.



Three Lessons in Collaboration for Data-Driven Organizations

Ineffective collaboration is a significant contributor to business failures, a recent survey found. And while most business executives understand this intuitively, the knowledge doesn't make collaboration any easier to achieve.

The profusion of data across the enterprise has made coordination even more complex, as siloed departments must share information with partners inside and outside the organization.

Talk to executives who have successfully synchronized their business, and you'll hear a common refrain: Organizations with a shared source of truth are faster, more effective, and better at controlling costs.

Business leaders are increasingly embracing maps as a source of truth that brings all parties onto the same page. GIS technology enables all stakeholders to share important information through a single platform.

The experience of Belfast-based broadband provider Fibrus reveals how GIS technology enhances collaboration. After winning a bid to bring internet connectivity to rural regions of Northern Ireland, Fibrus needed to coordinate a major infrastructure build-out with hundreds of employees, contractors, and subcontractors, while also reporting accurate information to investors and government leaders. GIS technology became a hub for information and collaboration.

"Our full C-suite has logins to GIS," says Ríain Garcia, senior manager of GIS at Fibrus. "Our investors have logins and even the government agencies we work with. . . . From the guy on the ground with the shovel to the highest employee, [they] all have logins, and they are being used."

GIS helped Fibrus save nearly US$6 million and reduce wasted time by 500 hours a week. The details of Fibrus's case are unique, but its principles can be adopted by any C-suite executive aiming to boost cooperation throughout an organization, regardless of industry.

With the unifying force of maps and dashboards, Fibrus increased accountability and transparency with contractors, communicated effectively throughout the project, and empowered stakeholders to make effective decisions.

Collaboration Lesson #1: Information Transparency Leads to Accountability

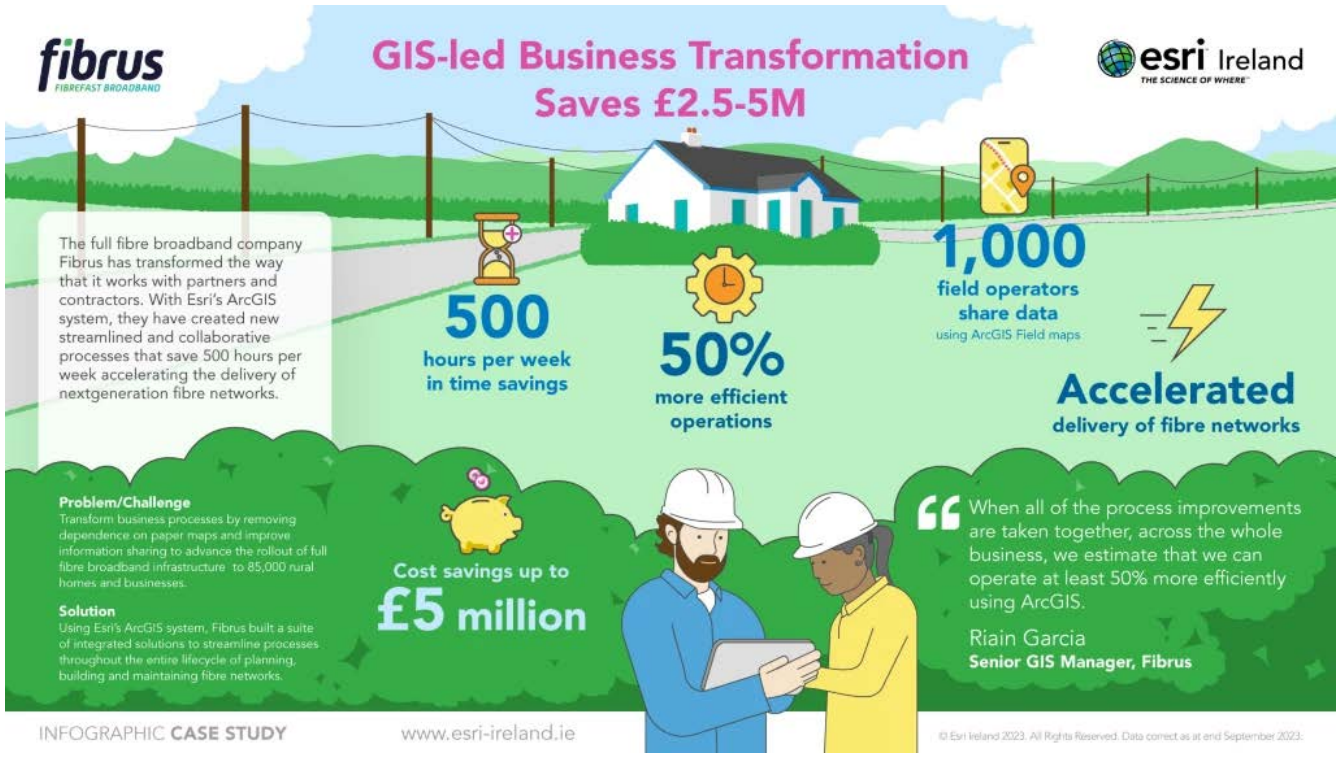
It's a familiar scenario: An email goes out to a dozen recipients requesting information or a decision. If responsibility isn't clearly demarcated, the result is often confusion and wasted time instead of collaboration.

> "We had to do things more efficiently. We knew that the timescales on the program were never going to be achievable unless we brought in something smarter."
>
> - Ríain Garcia, Fibrus

To deliver broadband connections to 85,000 homes, Fibrus worked with over 1,000 field operatives—contractors who dug trenches, strung cables, pitched poles, and more. GIS technology became the main communication channel for project managers and designers to exchange information about changes in real time.

If a pole needed to be moved during construction, design partners reviewed and approved the change from a GIS dashboard, eliminating the need for back-and-forth messaging.

"It's just a waste of time trying to find the right person to talk to or where particular information is that you're looking for," says Cade Wilkinson, head of planning at Fibrus. "That's where I'd say, across our business, the majority of our time savings has come from."



Transparency also played a role in streamlining billing for contractors and subcontractors. In the past, Fibrus managers might spend hours puzzling over what work had been completed when, and what to pay for it. After the company asked contractors to record all progress in GIS, delays and discord declined significantly. Both Fibrus managers and contractors could see on a map how many meters of cable had been installed that day, for instance.

The data delivered follow-on benefits, informing accurate estimates for later projects and ways of managing resources more efficiently.

With a smart map acting as a transparent project record, stakeholders avoided the confusion that can drain productivity and drive up costs.

"If it's not in GIS," Wilkinson says, "we're not trusting it."

Collaboration Lesson #2: Invite All Stakeholders In

Business leaders who think of all stakeholders as collaborators, incorporating their input into project planning and delivery, can take service to the next level.

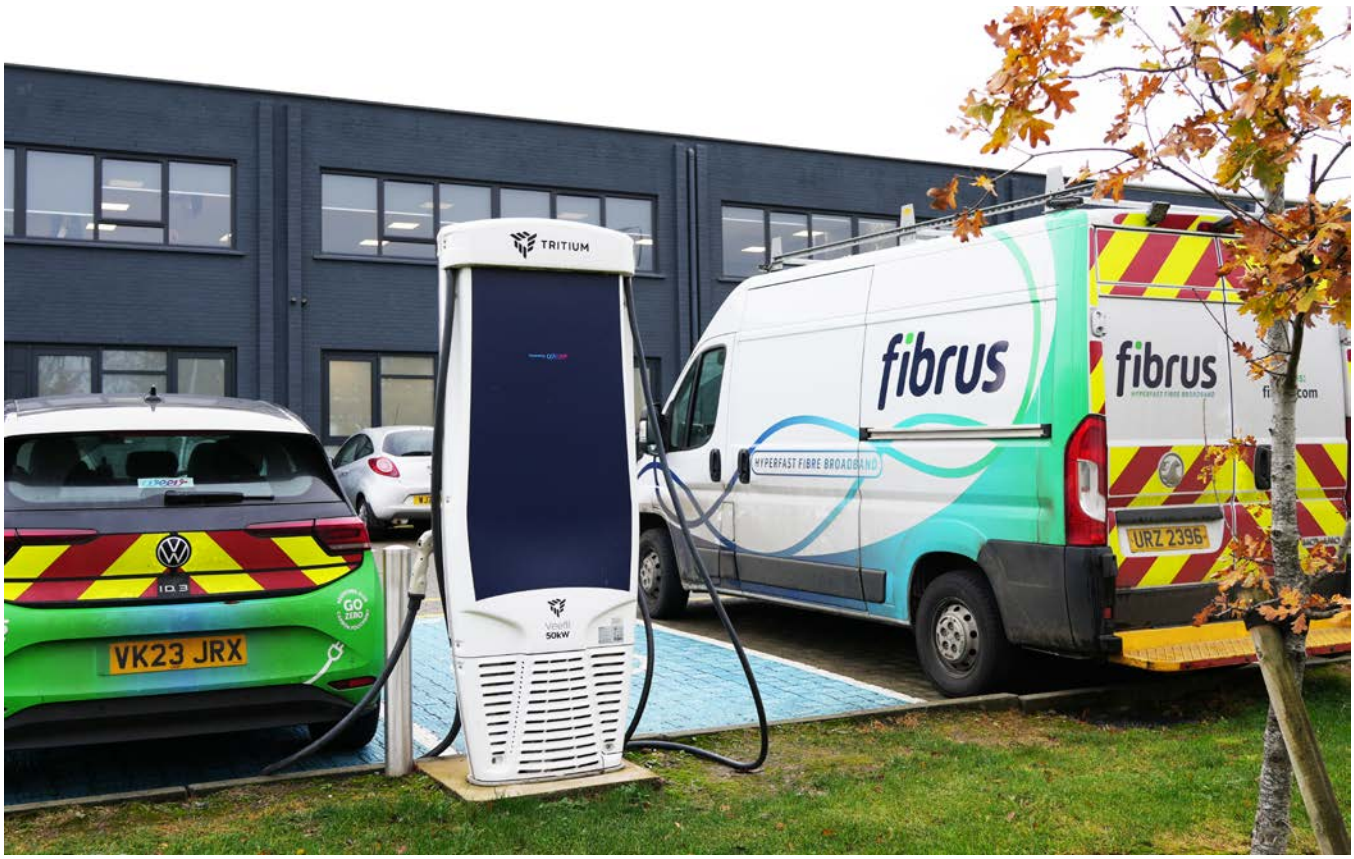
As Fibrus charted a path to deliver high-speed internet to tens of thousands of homes via fiber-optic cables, company planners consulted GIS to gain awareness of the property owners who would be affected by new broadband infrastructure.

Using location software, planners recorded important information, such as a resident's preference for an underground installation as opposed to poles. With that data stored in a central project hub, Fibrus gave customers a voice from the start of construction through the operations phase.

Once a contract was signed allowing construction to commence on a parcel of land, the agreement was photographed and uploaded to GIS. Contractors saw the property's color change on the digital map, signaling that work could begin. Site managers and others used the map to navigate to worksites and find contact information for landowners.

"It provides visibility to everybody," Wilkinson says.

Status updates also supplied context to investors and government sponsors like Building Digital UK and the Department for the Economy.



With GIS as a hub for data from the start, companies can avoid the complications and delays caused by information gaps.

Collaboration Lesson #3: Shared Dashboards Empower Action

Collaboration efforts are often hobbled by siloed information or departments that can't communicate effectively because they rely on different technologies. Fibrus showed that GIS can empower all stakeholders by making otherwise disparate data more accessible.

> "We have to follow very specific checks and balances. Really, the only way to keep track of that is within the polygon on the map."
>
> - Cade Wilkinson, Fibrus

The company's GIS dashboards allowed project leaders to assess at a glance the location of poles or the length of cable installed in certain locations. Compliance teams audited the network by reviewing data that site supervisors uploaded, while legal advisers pinpointed the location of outstanding permits.

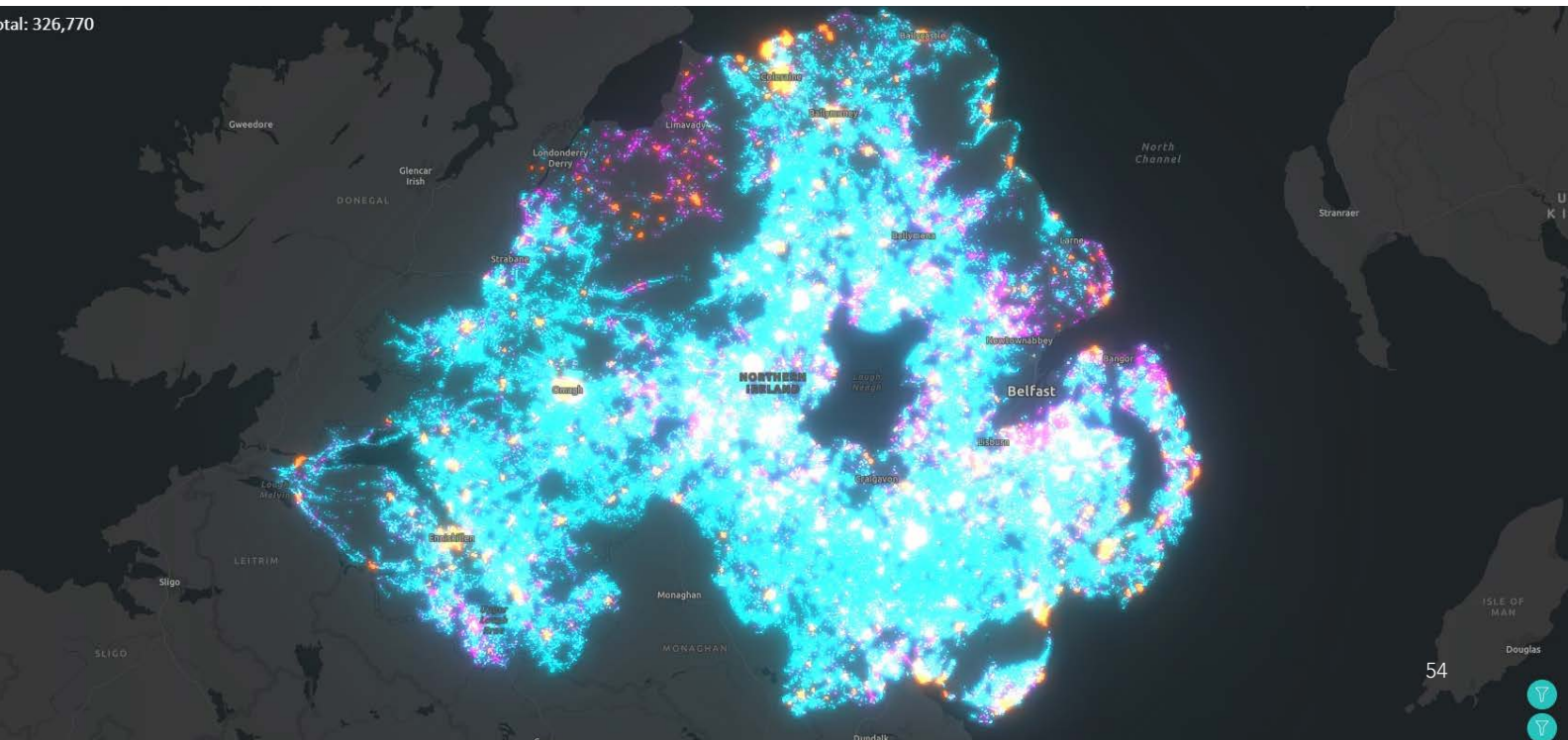
The dashboard also informed strategic decisions at the company's most senior levels. When a Fibrus team created a list of towns where the company might expand its service, Wilkinson converted the spreadsheet into a map. The geographic view was a reality check, revealing that certain towns couldn't be reached cost-effectively.

With the broadband network now operational, GIS technology powers a customer query portal that has helped resolve over 1,000 cases in less than a year. When a customer reports an issue like severed cables or a tilting pole, a call center representative logs the query in GIS and sees which regional team can handle it most efficiently. An automated email is sent to that department.

Once an issue is resolved, another automated email reaches call center managers who can review the update on a map and notify the customer that the issue has been resolved. Without the efficiency introduced by GIS, such cases would likely have taken far longer to settle.

A Case Study in Collaboration

When it comes to improving collaboration, a centralized system for storing, sharing, and analyzing information can overcome a host of business challenges. In fields ranging from corporate security to farming, GIS drives internal and external cooperation by unifying data and providing insights to multiple decision-makers. Executives are increasingly coming to see collaboration as essential to achieving efficiency and productivity—and GIS as a key technology that powers it.



Environmental Consultant Achieves Global Collaboration with Smart Maps

Consulting with companies on sustainability practices and environmental compliance is a growing business, projected to become a $36 billion slice of the global economy by 2027.

That growth is being fueled in part by increasing consumer interest in climate-friendly practices and a corporate trend toward improved environmental stewardship. Those forces and the ongoing drive for regulatory compliance make it vital for companies to receive fast, accurate environmental impact assessments so they can continue to grow responsibly.

To meet this rising need, one environmental consulting firm headquartered in Lisbon, Portugal, is discovering new value in a modern GIS. Company leaders have known that GIS technology can analyze massive amounts of data and plot the results on easy-to-understand smart maps. But now, the team at Bioinsight is finding that maps are also tools for collaboration, communication, and even project management.

> To better serve clients and keep the business competitive, Bioinsight has employed GIS technology to help teams collaborate across borders in as close to real time as possible.

Through mobile devices and a new generation of lightweight GIS apps, Bioinsight project managers stay in touch with the work of biological survey teams in remote areas on several continents.

As the environmental impact assessment industry grows more competitive, Bioinsight relies on location technology to not only help clients achieve their sustainability goals, but to ensure projects are completed faster and accurately, wherever in the world they take place.

Location Intelligence for Environmental Impact Assessments

As an environmental consultancy, Bioinsight analyzes how planned wind farms, pipelines, power substations, roads, and other structures will affect animal and plant life in areas under consideration for development.

Its environmental impact assessments give companies the data they need to lessen projects' ecological impacts, ensure regulatory compliance, and address any additional concerns up front.

Bioinsight CEO Miguel Mascarenhas says it's important to perform early location analysis and deliver quick, efficient impact assessments to help companies avoid environmental problems that might otherwise emerge after a site is operational.

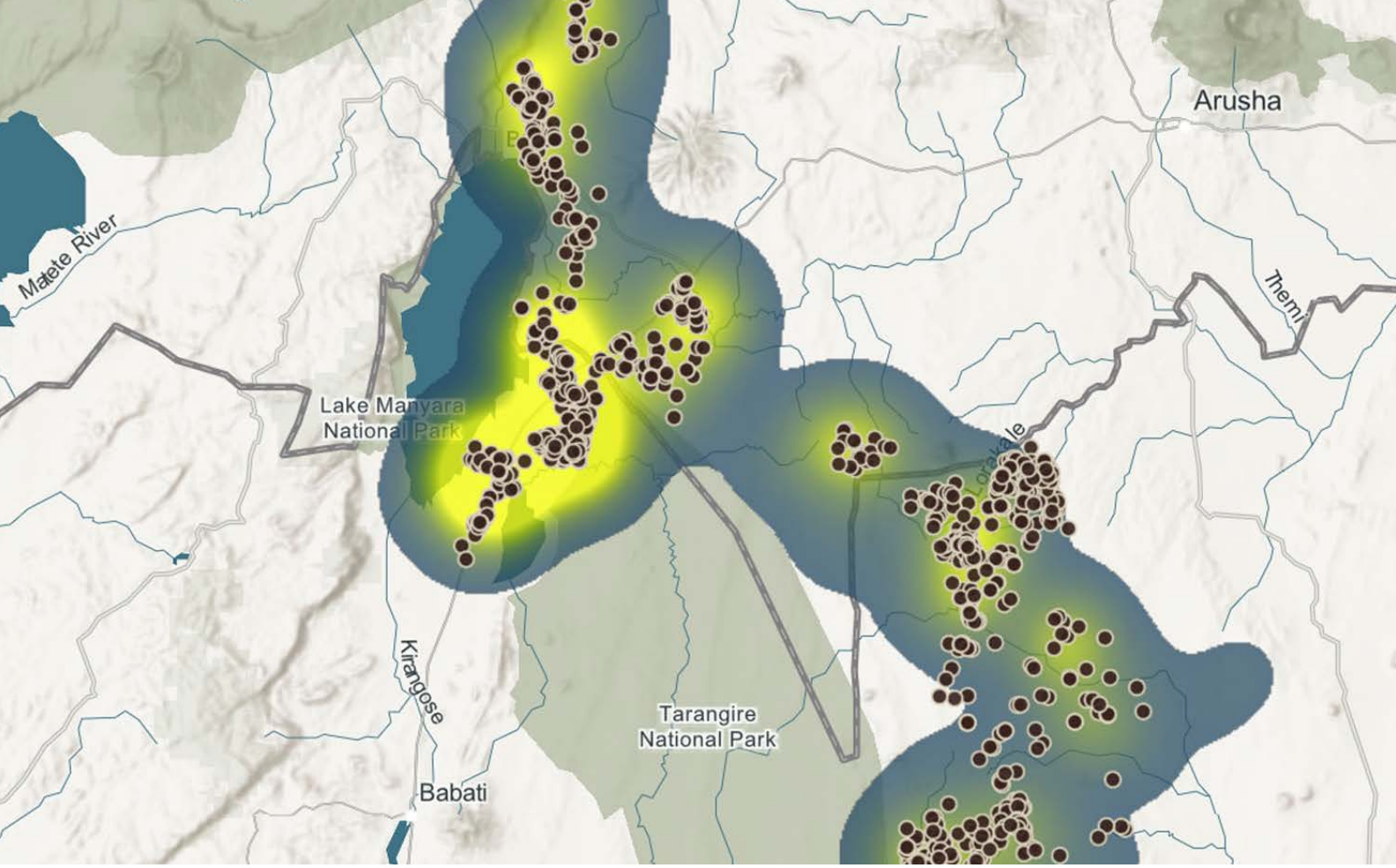
"Just to give you an example, we can be studying a road, and . . . we still don't have a specific project for the road, but we have different corridors for the implementation of the road," Mascarenhas says. "We start assessing which one of the corridors is going to have the least [environmental] impact and which one [we] should be avoiding."

The road might provide access to a wind farm, the most frequent subject of Bioinsight's environmental impact assessments. These sustainable energy projects continue to gain favor with customers and energy providers around the world, but they can't be built without impacting the surrounding location.

That's why Gonçalo Costa, a Bioinsight ecologist and large-carnivore specialist, says it's crucial to document the types of birds and their flight paths around a proposed wind farm site. And it usually must be done on a tight time frame.

> For this international company, the fast analysis and near real-time reporting enabled by GIS mean problems can be corrected on the fly rather than during late-stage project review.

"One of the things that we do . . . is to sample points for the movement of birds of prey around the area," Costa says. When the team performs that work with mobile GIS apps that automatically capture the location of data entered, the work is more



efficient. "It's practically done in the field," he says. "You have it [digitized], and it saves us a lot of time."

As competitors enter the marketplace, Bioinsight's use of GIS for communication and project management has been a game changer, according to Mascarenhas. "That can accelerate our job," he says. "That's something that's important for keeping our competitiveness."

Bioinsight's teams routinely use GIS mobile and desktop apps to monitor progress on different continents.

"If you have a plan where we need to go to 30 or 40 different places to collect data in remote areas, sometimes access is not easy, and we don't have any type of good reference points," Mascarenhas says. A smart map "is perfect to be able to look at when I'm at the office . . . and say, 'OK, the tasks of today have been done and the information has been collected.'"

Improved Collaboration Saves Time, Money

Just a few years ago, the process of sending teams of biologists into remote areas to survey animal and plant species could be very costly, time-consuming, and sometimes frustrating.

On-site researchers logged the type, number, and movement of species on paper along with details such as map coordinates, day, date, time, temperature, and weather. That and other project data was sent by mail to Bioinsight headquarters in Lisbon, where it was entered into spreadsheets and analyzed.

> "While the team is in the field, I can start looking at the data and make sure [it's] accurate and the data that I needed. If not, I can say, 'I need you to spend another day on the field.'"
>
> - Miguel Mascarenhas, Bioinsight

Considering the data's plodding journey through the mail and the time spent digitizing it, as many as five days might pass between data collection and an updated report. And the more times the information was handled or reentered, the higher the likelihood of a mistake.

To make matters worse, if the analysis revealed that the researchers were in the wrong spot or not observing the specified plants or animals in the required numbers, the project manager might need to direct the team back to the remote area to gather necessary data, a costly consequence in terms of time and money.

Bioinsight staff found they could communicate more efficiently through GIS technology.

"While the team is in the field, I can start looking at the data and make sure that the data are accurate and are the data that I needed," Mascarenhas says. "If not, I can contact them and say, 'I need you to spend another day on the field. Stay there. Don't come back.' That's important for us because sometimes I'm here in Portugal, but our project is in Brazil or is in South Africa."

Communication via Smart Maps

When biologists in the field in Brazil or elsewhere have smart maps on their mobile devices showing precisely where they need to survey animal and plant species and can log sightings on mobile GIS software, data is more accurate, collaboration is more natural, projects run more efficiently, and costs decline.

Whether they are in Lisbon or on a project site thousands of miles away, all who need to see the progress on an environmental assessment can check the shared smart map, a process that often alleviates the need for email or phone calls.

"I think the right word is communication," Mascarenhas says as he describes the benefits of GIS-based collaboration. "Because, again, people that work with us when they go to the field . . . already know what we need [them] to do." They just need a little guidance via digital maps.

Even if team members have to wait until they return to their lodgings at night to connect to the internet, the latest data is available just a few hours after it has been collected—much more efficient than the multiday lags that used to occur.

Expanding to Additional Stakeholders

Bioinsight's collaboration doesn't stop with company employees or subcontractors. The firm has found ways to extend the collaborative capabilities of GIS to its work with local residents. This allows more stakeholders to get involved in high-interest projects by performing tasks that don't require trained biologists.

In the northern part of Portugal, Bioinsight's staff set up game cameras in about 30 locations to document movements of the wolf population—an endangered species in Portugal and one that sometimes preys on livestock or pets. The goal is to document the movements of the small wolf population, educate residents, and promote conservation.

"It's a collaboration between us and the local people to join together in a project with a species of wolf that's sometimes problematic," da Costa says. "It's one of the examples where we can use GIS."

Bioinsight scientists set up the game cameras, then rely on a volunteer team to collect data after a set period of time.

"They are not GIS professionals," Costa says. But the smart maps on their phones guide the volunteers to the right locations. Once they've found the cameras, they send the SD cards to Lisbon. There, the Bioinsight team analyzes the images to understand wolf activity and monitor the health of the local population.

"I don't have to go on a second trip, spending the expense of going there," Mascarenhas says. "It's a good example also of how we can save money and interact with a local team."

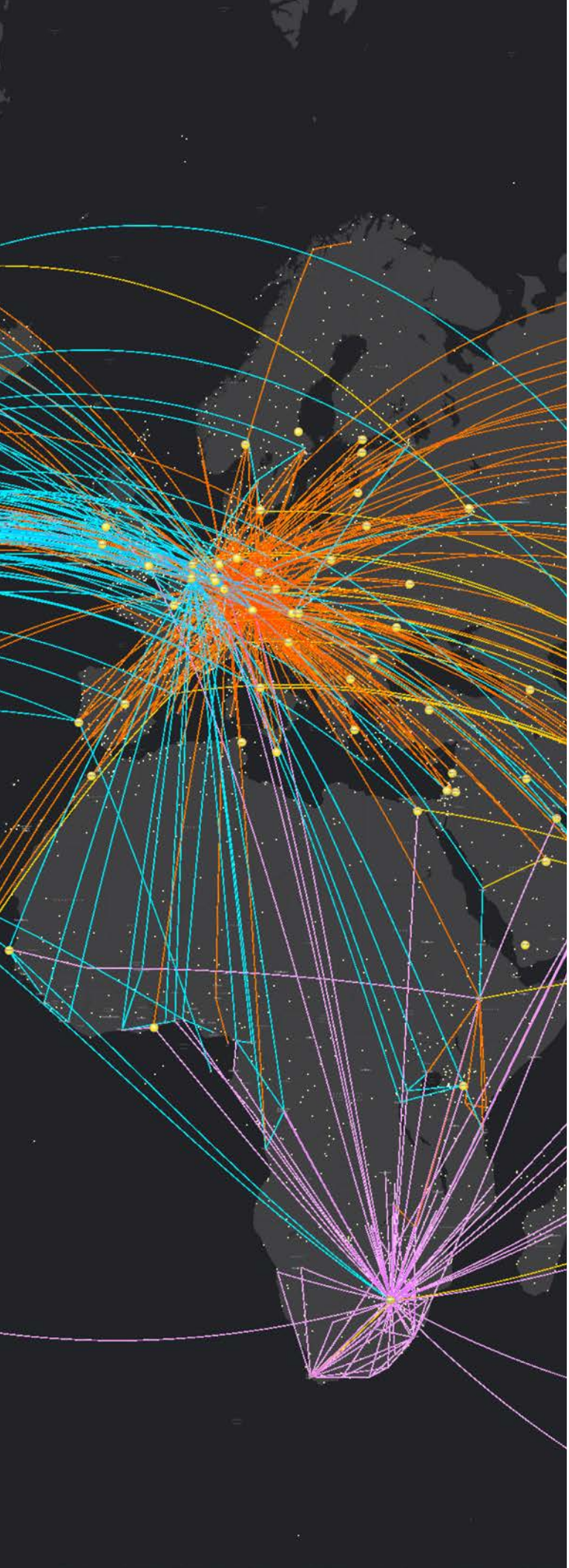
Where Next? More Collaboration, Greater Speed

The head of Bioinsight sees even more use of GIS and smart mapping for communication and project management going forward. Whatever type of assessment the team undertakes, the client benefits from the speed and accuracy of data collection, and Bioinsight distinguishes itself as a purveyor of fast, reliable environmental analysis.

"It's data communication and speed," Mascarenhas says, "to have the data as soon as possible on our desktop so that we can start analyzing and making decisions regarding the subject we are studying."

Supply Chain Optimization

At its core, supply chain management involves moving goods and people to precise locations within tight time frames—challenges that GIS technology is uniquely equipped to solve. Companies using GIS-powered supply chain optimization see reductions in delivery times, fuel costs, and inventory levels, while also improving customer satisfaction with more accurate delivery windows.



Supply Chain Optimization (continued)

Imagine having a map of the world with satellite data that monitors every port and identifies disruptions in near real time, enabling firms across the supply chain to immediately reroute shipments, adjust inventory levels, and mitigate losses when interruptions occur. This isn't theoretical—it's a functioning GIS-based tool developed by the International Monetary Fund (IMF) that promises to transform global supply chain resilience.

Supply chain became a household term during the COVID-19 pandemic, when one production chain after another—for hand sanitizer, ventilators, or automobiles—ground to a halt. The causes varied from health-related plant closures to outsize demand for critical materials. But they all exposed a fatal flaw in ordinary supply chains, which were so finely calibrated that they couldn't be nimble. The smallest disruption in one link easily broke the whole chain.

During those fraught days and the years that followed, a defining feature of modern business success was on full display in the supply chain: advantage through resilience. Companies with flexible supply chains tend to accelerate past their competitors when conditions deviate from the norm. This flexibility requires spatial awareness—a clear view of the business and its suppliers—and analytical prowess.

Such traits describe FedEx especially well. Every day, a geographic jigsaw puzzle of almost staggering complexity greets the world's second-largest delivery firm. For some of the company's location specialists and GIS experts, supply chain optimization means coordinating the critical task of airplane maintenance—a ballet of parts, planes, and people. It's an operational challenge tailor-made for GIS analysis.

At Cisco, the service supply chain is a paragon of optimization. The company's equipment has been described as the backbone of the internet, enabling vital services at financial trading firms, hospitals, and data centers worldwide. Cisco created a GIS digital twin of its service supply chain—including parts depots and customer locations—to ensure it could meet contractual obligations to deliver parts and service on time.

These companies are taking a holistic approach to the supply chain, using location technology to design and optimize their networks. When unforeseen circumstances emerge, they have the location intelligence they need to navigate around it.

Spatial Thinking Is Everywhere and It's Changing Everything

FedEx is one of those companies that epitomizes the modern idea of efficiency: Deliver a document or a package anywhere in the US overnight—guaranteed. The company stands as a symbol of operational wizardry, with a fleet of gleaming white airplanes and battalions of purple-shirted staff. The package handed across a FedEx counter in Orlando at 4:00 p.m. Tuesday appears in an office in San Diego before noon Wednesday.

To keep that happening, FedEx's more than 700 jets need routine maintenance. That maintenance requires exactly the right parts from inventories of thousands of spares, and it requires the right mechanic in the right airport in a global network of 650. But FedEx can't have planes sitting idly on the ground, waiting for a part or a mechanic.

Hence the puzzle: how to consistently get all three elements—plane, parts, and person—in the right place at the right time.

"It's a ballet," says Sheila Davis, manager of FedEx's IT enterprise platform for geography. Airline operations turned to Davis's IT group, an innovative FedEx team that uses location technology and spatial analytics—often, quite literally, maps loaded with data—to solve problems.

For this problem, like many others, the key is geography. You need to know where everything is, all the time.

As Davis explains, "There's a lot of coordination that has to take place—getting the part of a plane on another plane, [and] once that plane with the part reaches the destination, coordinating having a mechanic available.

"We gave Air Ops some insight, mainly using visualization, looking—spatially—at all the planes in our network. Which planes were in flight, or about to take off? When would they arrive?"

At a glance, FedEx Air Ops could see how to get planes needing maintenance, and the parts they required, to the same place at the same time. Then they could schedule mechanics smartly. Seeing the status of the whole FedEx flight network in real time unraveled a puzzle that screens of data made worse.

The result: Maintenance happens more efficiently. Just as important, planning the maintenance process itself takes many fewer work hours. Costs are lower; maintenance performance is higher.

That's the power—really, almost the magic—of bringing spatial analytics or the geographic approach to bear on a whole array of challenges, from communication to long-term strategy to risk reduction. Geography and visualization turn out to be a missing tool that unlocks remarkable insights, efficiencies, even hidden opportunities for growth.

The biggest companies in the world have discovered the impact of spatial thinking and are using it to tackle a surprising range of problem-solving.

At FedEx, Davis's group has created self-service tools, and spatial thinking is so broadly useful that groups inside FedEx are building their own maps, applications, and dashboards.

"It's really interesting to see those teams able to answer their own questions," Davis says. "We're getting team members to think about solving problems in a different way—in a spatial way. That's definitely rewarding."

Spatial thinking or the geographic approach is a decision-making tool. A planning tool. A tool of data analysis, data modeling, and data presentation. It's a collaboration tool, a communication tool, and a transparency tool. In other words, in the words of those in the best position to know in the first place, it's an especially useful tool for an especially challenging time.

How Cisco Created a GIS-Based Digital Twin of Its Service Supply Chain

Imagine a supply chain delivering parts and service to millions of customer sites in more than 130 countries—often within two hours of a customer's request. That's a challenge we take seriously at Cisco, where every minute of downtime can cost our customers revenue.

As a large IT company, Cisco knows how to be in many places at once and still provide service that feels personal. That gives Cisco an edge in the hypercompetitive market for networking and security technology.

To deliver fast and effective technical support, the company relies in part on a digital twin powered by GIS technology. The location intelligence we derive from this digital twin helps us manage a service supply chain of global complexity—while maintaining high levels of customer satisfaction.

A Digital Twin for the Service Supply Chain

Cisco's service supply chain repairs and replaces products ranging from servers in data centers and networking switches to videoconferencing systems in offices and executive boardrooms.

At the heart of our service network are the global and local vendors who fulfill a wide range of service-level commitments for Cisco customers. Collectively, these vendors manage more than 1,300 warehouses for spare part positioning and allow us to leverage a global field services force of thousands of engineers.

To ensure that the service supply chain runs efficiently, we created a digital twin called the Service Delivery Insights Platform (SDIP), a central nervous system connecting logistics, field services,

planning, order management, and sales support. Fueled by a set of business rules and GIS-based location intelligence, the SDIP provides near real-time awareness, allowing us to dispatch spare parts and technicians from the most appropriate warehouse and engineer base. This has improved spare-part inventory planning and field service team availability.

With GIS as its core, the SDIP acts as an intelligent mapping platform, displaying vendors' service capabilities and response areas. The SDIP also displays a digital twin of the road network, automatically calculates how far vendors can travel to deliver service in a region, and assesses shipping methods for spare-parts delivery.

To optimize service delivery, the SDIP matches the right talent and depot location to the customer's need by assessing engineers' technical skills and warehouse processing times. In doing so, it helps us meet service delivery deadlines and customer expectations.

This innovative system takes automation to a new level, enabling Cisco's service supply chain to adapt quickly to the realities of each customer and region.

Investing in Location Intelligence Improves Outcomes

The transformation of Cisco's service supply chain from a spreadsheet-based process to a near real-time digital twin represents an investment in reliable data, intelligent systems, and—most of all—our customers. The SDIP thrives on geographic data, and ensuring the precision of this data is an ongoing process of simplification. We recently transitioned from maintaining millions of destination addresses to only maintaining our dispatch locations, letting the system calculate the service coverage area for each. This has led to a near elimination of data maintenance, and has fueled many of our service improvements.

When a Cisco customer submits a return material authorization (RMA), the SDIP automatically recognizes the customer address and calculates which of our 1,300 warehouses can reach that location within the contractually specified time. The system then checks available parts inventory nearby and analyzes local and international trade barriers that could limit border crossings. The result may show that multiple warehouses can serve the customer, so GIS weighs distance and drive-time considerations to select the one most suitable to dispatch the part.

Because we have customers across the globe, this activity goes on around the clock. The assignment process is complex, especially when calls are routed to a country with different trade restrictions and tax jurisdictions. The SDIP automates the assignment process, checking established business rules and dispatching the request to the right warehouse—avoiding human error and accelerating execution. This level of automation enables Cisco to handle hundreds of thousands of RMAs each year.

> "For any business that relies on delivering services or parts to customers effectively, location intelligence is a must-have capability"
>
> -Warner de Gooijer, Cisco

We are experimenting with integrating real-time traffic and weather information into the digital twin to help field service engineers reach customer sites safely and even more quickly. Through this automated location intelligence, we will be better equipped to achieve the ultimate goal of having the part and the engineer arrive simultaneously.

Inventory Optimization

As a company that prides itself on exceptional customer service, Cisco values a highly accurate view of our service capabilities. Location intelligence helps answer crucial questions such as: Where are our service gaps? Where do we already sell a service and where do we need to add depots? Where do we have too many warehouses?

GIS technology helped us see that we had significant overlap in our service areas and allowed us to right-size our warehouse network and inventory. Previously, one city might have been reached by several warehouses, and there was no hierarchy governing how a customer was assigned to a particular warehouse. By applying location intelligence and business rules through GIS, we ensured the right locations for our warehouse network.

This optimization spurs higher ROI. We've been able to reduce unnecessary inventory and phase out redundant depots. When you consider the size of our spare parts inventory—valued in the billions of dollars—and the fact that SDIP has contributed to inventory savings alone in the high single digits, you can glean how significant these changes have been to our global operations.

The Value of Innovation

Honoring our commitments to millions of customers in more than 130 countries is a critical mission at Cisco. In a fast-paced global marketplace, the geospatially enabled SDIP delivers value not only by improving customer uptime, but by improving operations in other areas of our business.

Globally, Cisco stocks hundreds of thousands of service parts, and our logistics team has used the location intelligence derived from SDIP to create a hub-and-spoke distribution model. The resultant economies of scale have helped us significantly improve spare-parts inventory positioning.

With GIS technology delivering up-to-date location information to SDIP's digital twin, our team can focus on the value-rich work of improving customer experience, rather than on data curation.

> "Cisco's use of GIS has yielded several benefits: more efficient parts routing, smarter warehouse locations, optimized inventory, and—most important—the ability to better meet a wider range of customer needs."
>
> -Warner de Gooijer, Cisco

SDIP also improves territory accuracy and visibility by creating a reliable single source of truth for Cisco's global service supply chain. The system automatically assigns new customers to the appropriate depot and adjusts assignments when warehouses move, or configurations are altered.

The system captures and recognizes trade barriers in a manner designed to ensure compliance with local and global trade restrictions and quickly updates coverage capabilities when road networks are expanded.

With GIS technology as a foundational component in Cisco's Service Delivery Insights Platform, the company continues to drive digitization, automation, and operational efficiencies, delivering reliable service for customers who need dedicated support to ensure business continuity.

Monitoring Global Trade with GIS and Satellite Data

Introduction

Highly interconnected ports are among the most important infrastructure components for facilitating the flow of goods ranging from clothing to food. Maritime trade plays a critical role in the economic activity of many countries because ports handle 80 percent of world trade volume. But human-made and natural disasters at ports can create widespread global impacts. In March 2021, when the *Ever Given*, one of the largest container ships in the world, got stuck and blocked the Suez Canal—the shortest maritime route between Europe and Asia with a transit time of six-and-a-half days—it disrupted trade worth $2.5 billion. When flooding damaged the port of Durban, the largest port in South Africa, and when an earthquake damaged the Iskenderun port in Turkey, for instance, these natural disasters caused a ripple effect on trading partners in the region.

Monitoring ports enables governments and other organizations to analyze economic impacts that result from natural disasters or other large-scale events accurately and quickly.

The International Monetary Fund (IMF), in collaboration with the University of Oxford, created PortWatch, an open platform for policymakers and anyone who wants early insight into the potential repercussions of an issue at a port. PortWatch uses satellite-based vessel data and GIS technology to monitor port activity and simulate the impacts of port disruptions on global trade. This allows decision-makers to implement policies more effectively to cope with that shock, promoting economic and financial stability.

"Having this information is useful for policymakers to track how well countries are doing in terms of the economy, especially when there is an economic downturn or recovery," said Serkan Arslanalp, an economist at the IMF.

Solution

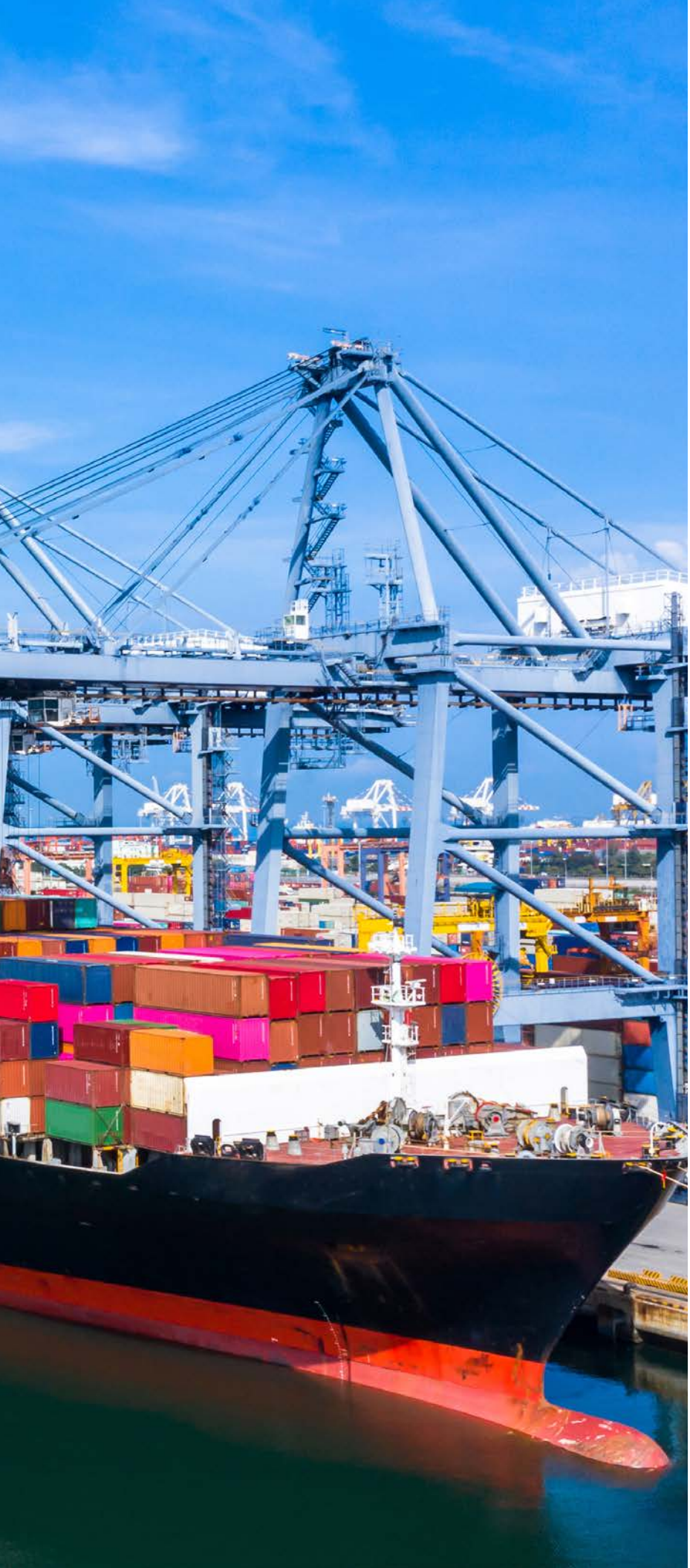
Policymakers can sign up on PortWatch to get email alerts when a disaster may impact a port. Given considerable lags, trade data is often not available in near real time. "Monitoring the ports in real time allows you to essentially have your finger on the pulse of the economy," Arslanalp said.

PortWatch is hosted on the cloud-based ArcGIS Hub℠, leveraging vessel positions captured by satellites to broaden the scope of people and countries that can access near real-time port data. This allows the IMF team to easily store data and make it available to member countries. The technology also makes it easy to visualize, update, and share automated port data. Additionally, ArcGIS Experience Builder is built into the platform for users to simulate spillovers from hypothetical disruptions and climate scenarios that may impact ports.

"The tools embedded in PortWatch illuminate complexities and interconnections in the international maritime trade that would remain otherwise difficult to grasp," said Alessandra Sozzi, data scientist at the IMF. "It's not just about seeing, it's about understanding."

By leveraging satellite data and GIS technology, IMF economists, business owners, journalists, maritime experts, port authorities, and policymakers across the globe can quickly identify economic patterns, fill information gaps, and detect early warning signs of economic instability of human-made and natural disasters at ports and maritime choke points.

"PortWatch produces maritime trade data that is complementary to officials' trade data," said Parisa Kamali, an economist at the IMF. "This data is



specifically valuable for countries with low statistical capacity and high reliance on trade for consumption and growth."

Results

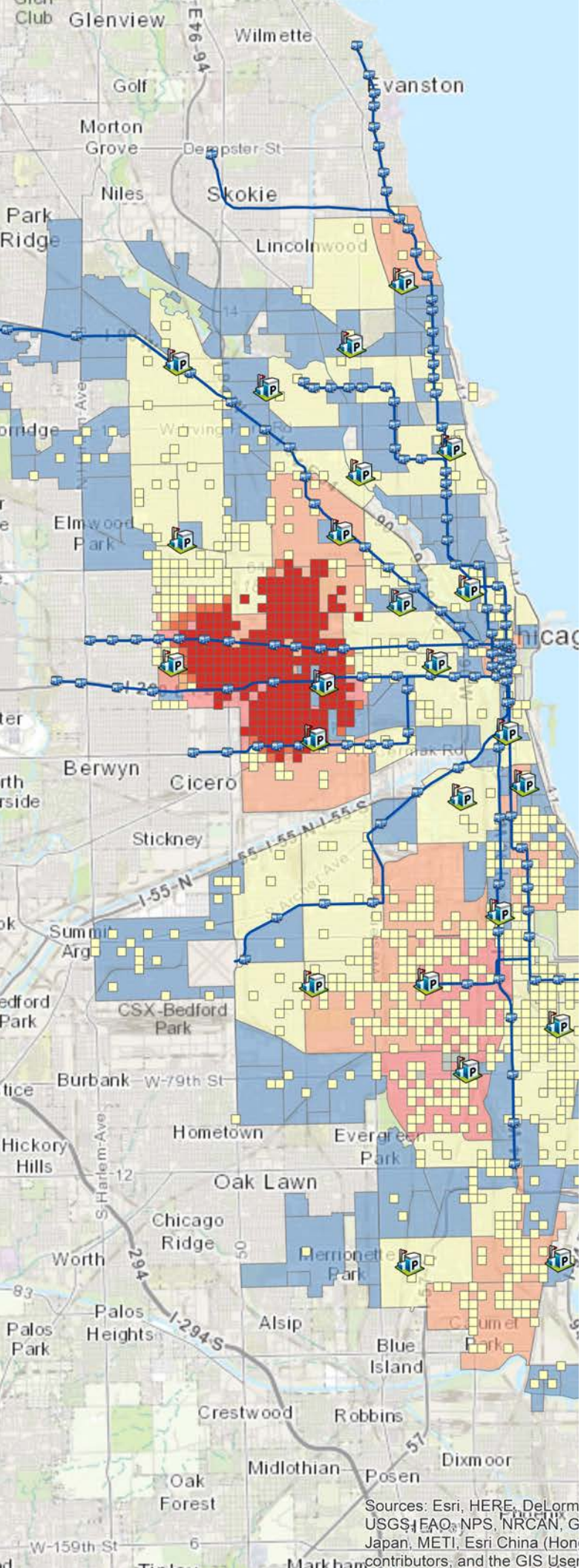
The IMF launched the PortWatch online platform in November 2023. Since then, thousands of users from news organizations, businesses, and policy institutions have used the platform, and several hundred have signed up for email alerts about natural disasters that may impact trade routes.

The IMF's vision for PortWatch's future is to turn it into a widely used resource on trade disruptions. "The recent crisis in the Red Sea shows the potential for PortWatch to be a resource for trade disruptions beyond climate extremes and natural disasters," said Robin Koepke, an economist at the IMF.

> "ArcGIS software has enabled the public to interact and work with various pieces of output from our research, bringing science into the hands of the public"
>
> -Jasper Verschuur,
> University of Oxford

Operations Safety and Security

The modern enterprise is more dispersed than ever, and the duty to protect employees does not cease once they travel beyond the office. Spatial awareness enables security teams to precisely track where on-the-job professionals are located and identify region-specific threats in real time, reducing response times and significantly improving safety outcomes.



Operations Safety and Security (continued)

Out of sight, out of mind is not a philosophy executives associate with their employees. And yet the sprawling modern enterprise—with professionals in the field, at industry events, and on-site with clients—is a CXO's security nightmare.

Situational awareness, a term once reserved for law enforcement officers and military personnel, is now a fixture of the boardroom. The best way to achieve it, some executives have found, is through a combination of real-time data and GIS technology that brings critical information into a spatial context.

In safety-minded organizations, spatial thinking often sets the stage for new levels of security. Duke Energy benefited from a collaboration between its GIS group and its Enterprise Security Command Center team. Together, they created a system of maps showing a neighborhood's crime data along with AI-powered alerts of active incidents in an area. With that data, field technicians have greater situational awareness before heading out on service calls.

As recent headlines on retail crime underscore, smash-and-grab robberies and threats of violence have rattled frontline employees and the companies they represent. An industry group called the Loss Prevention Research Council is working to address the problem, using location analytics to spot patterns in retail theft and disrupt the networks behind the incidents.

Meanwhile, operational leaders at BP Bioenergy in Brazil are taking a spatial view of safety and efficiency for workers who convert sugarcane into green energy. Across thousands of hectares of fields and thousands of miles of private roads, GIS maps now swiftly guide medical personnel to workers in need, saving precious minutes.

As an increasingly distributed workforce encounters an increasingly volatile threat environment, executives are turning to location data and GIS mapping to create the visibility that ensures no one is out of reach, even when they're out of sight.

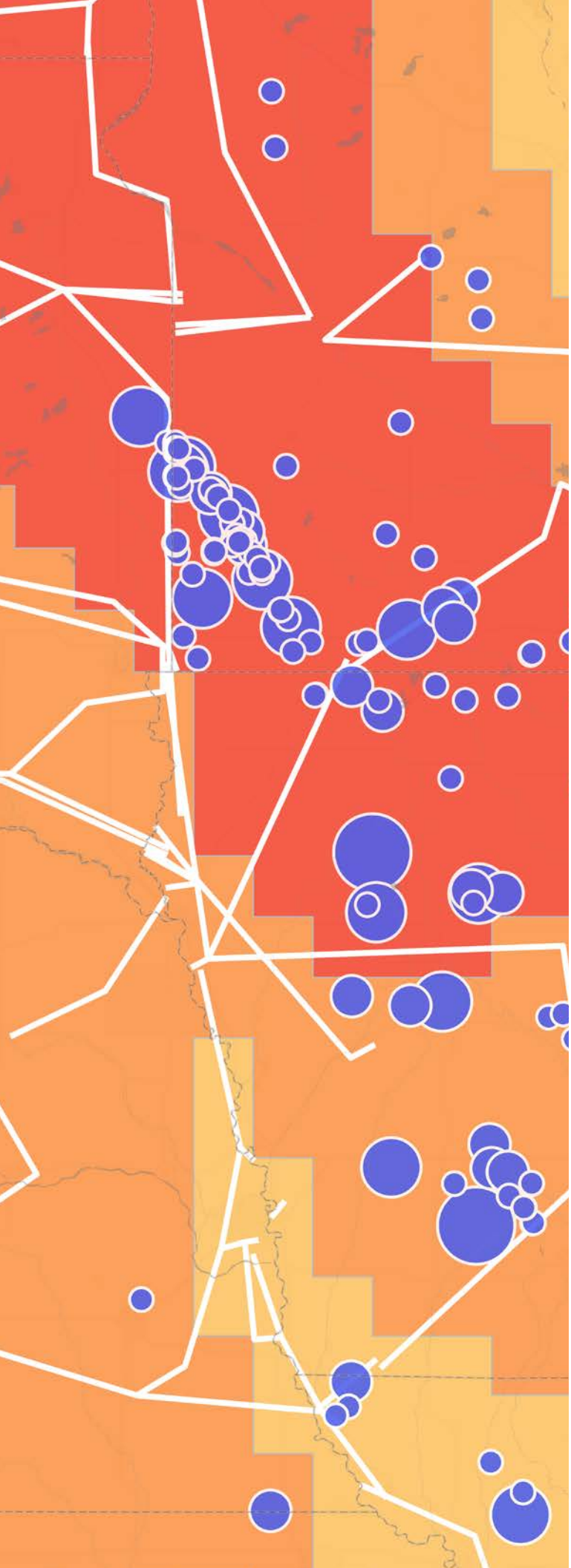
A Call for Collaboration Strengthens Corporate Security

When Amy Barron took the stage at a 2021 internal summit for Duke Energy—one of the largest utilities in the United States—she issued an ambitious call for collaboration.

A 16-year veteran of the company, Barron leads the GIS team supporting customer delivery in North and South Carolina. On stage, she said the GIS-based smart maps used throughout Duke Energy were just a start. If used strategically, the technology could provide deeper geographic context, known as location intelligence, that would streamline workflows and improve decision-making.

In the audience that day was Jason Haden, manager of Duke Energy's Enterprise Security Command Center, which monitors the utility's facilities 24/7/365. Haden had been thinking about ways to bridge resources among other security operations at Duke Energy, including cybersecurity, compliance, and threat intelligence.

Barron's speech underscored that geography could be the common ground for those partnerships, Haden says. "Because of mergers over the years, there were many things about security elements and security features that were disparate across our seven-state footprint. The question was: How do we unify that?" Haden says. "After hearing Amy talk about the unification of GIS, I was like, 'We've got to do this.'"



Collaboration Built on the Power of Location

It wasn't the first time Duke Energy's GIS team had collaborated with the company's physical security team. Haden had previously worked with senior GIS analyst Garrett McKinney and lead intelligence analyst Forrest Kelley to create a GIS-powered Threat Awareness Portal. The GIS dashboard reveals crime data, a live feed of location-tagged incidents, and other key data points. The Threat Awareness Portal is a hub for information that each security division can tailor to its needs.

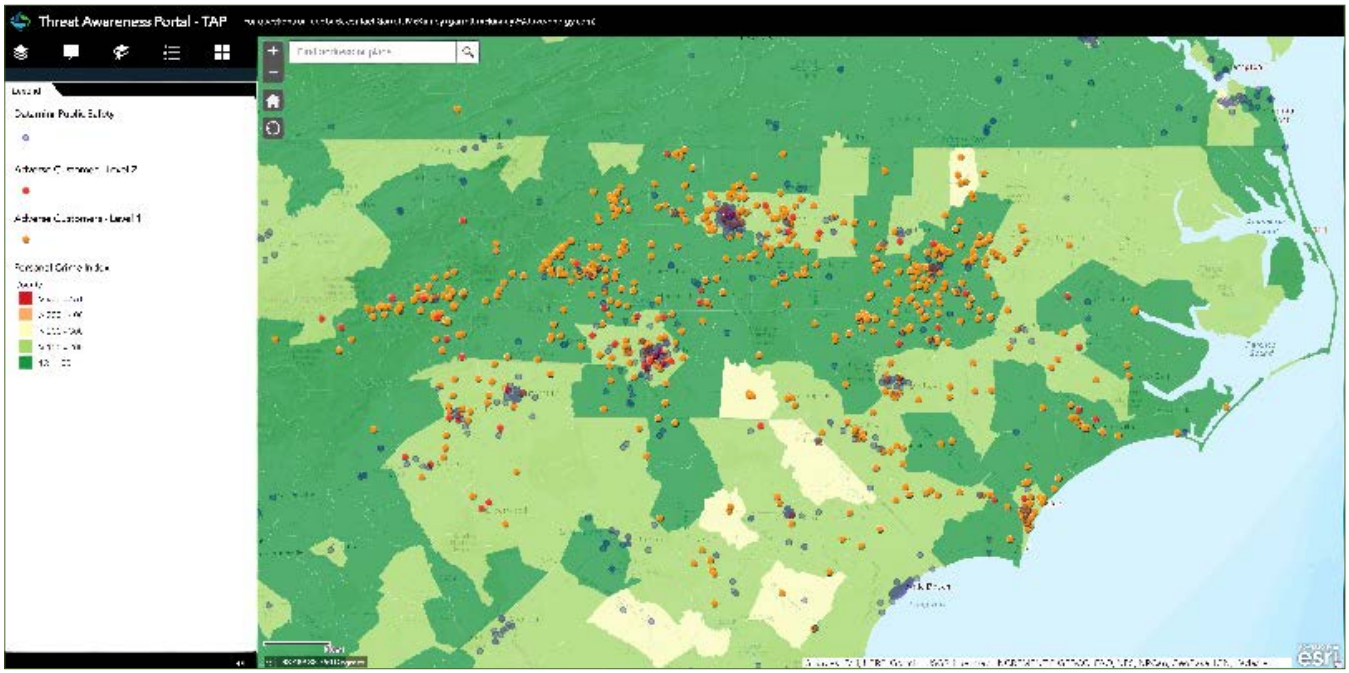
> Safety has always been a focus for the country's second-largest public utility. When security personnel teamed up with GIS analysts, they created a new level of awareness for the company and its employees.

But the unifying potential of location intelligence went further still. Once Haden, McKinney, and Kelley saw how useful the dashboard's insights were to their teams, they quickly realized that business units across the company could benefit from them as well, especially Duke Energy's approximately 12,000 field employees.

"With a territory as large as ours, you can't see everything, you can't know everything," Barron says. "But you can start by having people share data and awareness of things that they're seeing and doing."

The security team partnered with McKinney and other GIS colleagues to scale the Threat Awareness Portal to every business unit in the company. The data-driven platform now gives Duke Energy employees a new level of situational awareness to make smart calls about safety.

It's a process that owes much to the catalyzing influence of Barron, who helped colleagues collaborate through location intelligence.



Security Insights Revealed by GIS

GIS is integral to Duke Energy's business, thanks in part to the efforts of Barron, who helps colleagues see its relevance across multiple departments—often through the GIS Day activities she sponsors. Company leaders use location technology to monitor transmission, distribution, and gas assets, as well as security.

As one of the nation's largest energy holding companies, Duke Energy understands its responsibility to protect its assets and information, and has a multilayered security strategy focused on preventing cyber events and threats to critical infrastructure. The company's electric utilities serve more than 8.6 million customers across six states, and its natural gas unit serves 1.7 million customers across five states. While tending to this sprawling network of assets, lineworkers and technicians occasionally find themselves in the vicinity of ongoing incidents that are unrelated to Duke Energy's work.

> "With a territory as large as ours, you can't see everything, you can't know everything. But you can start by having people share data and awareness of things that they're seeing and doing"
>
> -Amy Barron, Duke Energy

While these incidents aren't common, Kelley says, any business that regularly interacts with the public can encounter these scenarios occasionally. That's why Duke Energy—which sees safety as its top priority—wanted to give teammates in the field as much visibility into their surroundings as possible.

So Haden and Kelley, with help from McKinney, expanded the Threat Awareness Portal to give workers better awareness of their surroundings when in the field. When employees log in to the portal, they see a map displaying counties color-coded for historical crime data, with darker hues signaling higher annual rates of personal crime. Orange dots indicate lower-level threats, while red dots signal a more serious hazard.

For additional context, an AI-powered app called Dataminr scans social media accounts and other sources of public data to provide real-time information on emerging risks, which appear on the map as blue dots. A technician leaving the depot can see at a glance whether an altercation occurred that morning on the block where they've been assigned.

Duke Energy's security leaders felt smart maps were the most effective way to communicate the data and equip employees.

"We've got crime data down to the city block," Kelley says. "You can really visualize, 'I'm here right now, and I'm going here. Is there anything between here and there that could impact me?'"

A Unified Security Platform

One of the first steps in creating the Threat Awareness Portal was ensuring that all the company's assets—from substations to thousands of miles of power lines—were accurately mapped. This can be a challenge for organizations that have expanded through acquisitions, as data can become siloed by organizational barriers.

GIS tends to break through those barriers by serving as the authoritative source for location data. Duke Energy's maps allow security professionals to gauge whether reports of social unrest, crime, or even geopolitical risks occur in proximity to any of the utility's infrastructure.

> "Instead of having to flip from one app to another to see the different pieces, now it's all in one big picture."
>
> -Garrett McKinney, Duke Energy

"Anytime we have a developing event, the first thing we do is jump on the GIS platform and pull up our layers," Kelley says.

With this information in hand, the security teams can issue status updates to company leaders, local law enforcement, or even federal officials, depending on the level of severity.

"We've got such a large footprint with thousands of assets that vary in criticality," Kelley says. "Getting plugged into GIS and getting the [map] layers that have our generation, transmission, distribution assets, and all of our gas assets has been huge for us."

How Location Intelligence Gives Leaders "One Big Picture"

The Threat Awareness Portal also enables Kelley and his team to detect location-based patterns in security threats and shore up defenses accordingly. For instance, location intelligence could help them trace reports of activities by a violent extremist group, which could lead Duke Energy to increase security near a particular asset or area.

With McKinney's help, Kelley used location insights to build a security risk map that informs executive decisions. This smart map assigns a risk score to every county where Duke Energy operates by analyzing annual crime rates, employee presence, security assets and personnel, and the location of critical facilities.

"Instead of having to flip from one app to another to see the different pieces, now it's all in one big picture," McKinney says.

The Future of Corporate Security

Duke Energy's safety culture thrives on continuous improvement, and the team's next step is to make the Threat Awareness Portal available on mobile devices so workers can check threat assessments from the field. Duke Energy's trucks are also telemetry-enabled, raising the possibility of strategic geofencing. That GIS capability would automatically send an alert to an employee's phone when they drive into a high-risk area or a neighborhood where a crime has occurred.

Incidents in the field are rare, but when they occur, the location intelligence in Duke Energy's security portal gives employees the situational awareness they need to respond.

"I think it's one of the biggest achievements we will have made in the five years since I've been here," Haden says of the collaboration that brought the security app to life. "It's a tangible way that the information we gather and push out is helping the entire Duke Energy company."

The Art and Science of Securing Goods from Manufacturing to Point of Sale

As a store detective in the early days of his career, Read Hayes never would have guessed that he'd someday gather executives around digital maps to study patterns of retail theft. Back then, he placed metal pins in paper maps, hoping to understand whether merchandise was disappearing from certain store departments more than others.

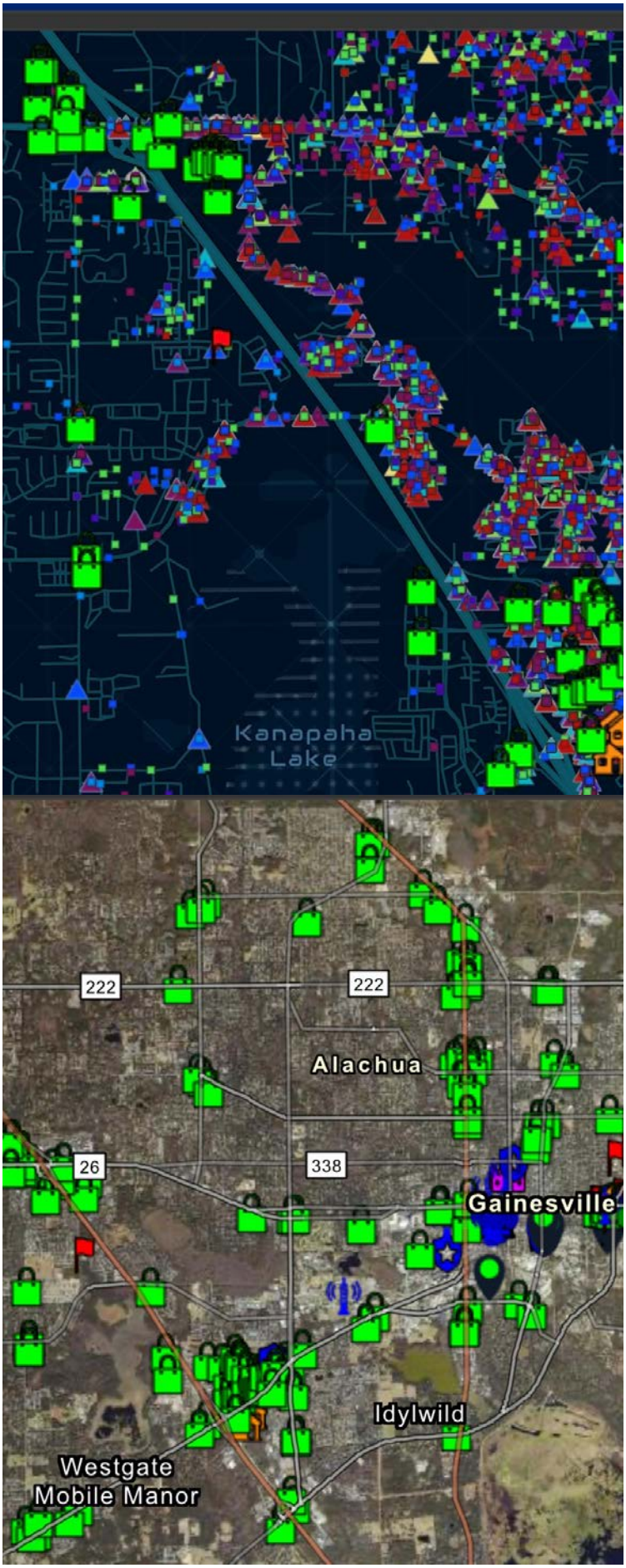
After several years in loss prevention, Hayes earned a PhD in criminology and founded the Loss Prevention Research Council in 2000 with 10 major retailers. Today, the group numbers almost 70, and Hayes has left the paper maps far behind. The council uses modern GIS technology to detect patterns in retail crime and give retailers the operational awareness they need to keep products, employees, and customers safe.

"It's a way for everybody to gather around the table with that kind of mapping to . . . think about these [events]," Hayes explains. "Why are they happening here and not here?"

Evolving Criminal Trends, from Retail Theft Through the Supply Chain

Retail theft has been in the spotlight since the COVID-19 pandemic. Pharmacy chain CVS says in-store theft has soared 300 percent since 2020. That's just one chain, and shoplifting is only one piece of the puzzle.

Organized, sometimes violent retail crime is also expanding in scope and scale. Prominent, upscale



retail brands are increasingly falling victim to coordinated smash-and-grab attacks. Thieves are netting tens of thousands of dollars' worth of high-end products in minutes, and 86 percent of leading retailers say criminals have threatened store associates. Online platforms and marketplaces provide nearly frictionless ways to liquidate stolen goods.

> Counterfeiting, cargo theft, retail smash-and-grabs—from the beginning of the supply chain to the end, products have always been vulnerable to bad actors. Now location-aware technology is providing operational awareness for loss prevention.

On their own, incidents of retail crime might appear random. But GIS technology is helping to reveal patterns. Indeed, the go-to technology for market analysis and store selection for prominent retailers is now providing operational awareness on retail crime.

"Being able to visualize and identify where clusters of issues are occurring, possible patterns, or how things might be evolving—or if there is some temporal-spatial movement [like] they're moving from east to west, for example—those are going to be very important," Hayes says. "That's where we're headed right now with mapping."

As retailers gain operational awareness in and around their stores, other supply chain players are asking a new question: How can we use location intelligence to ensure that products make it to store shelves in the first place?

Using Location Intelligence to Secure the Supply Chain

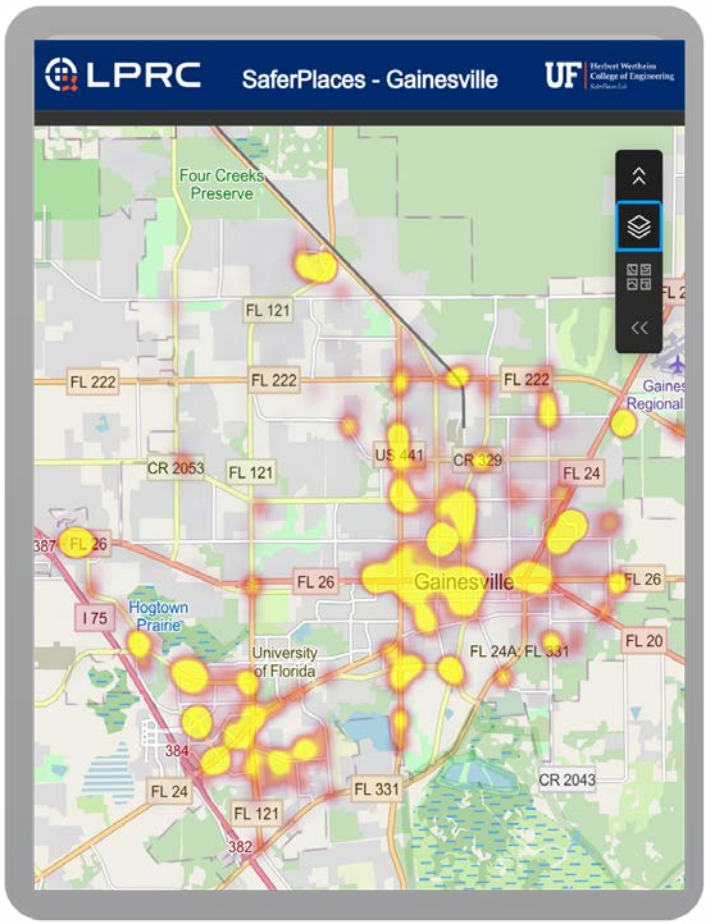
Although media coverage often focuses on retail theft, securing goods is a challenge at every stage of the supply chain, from

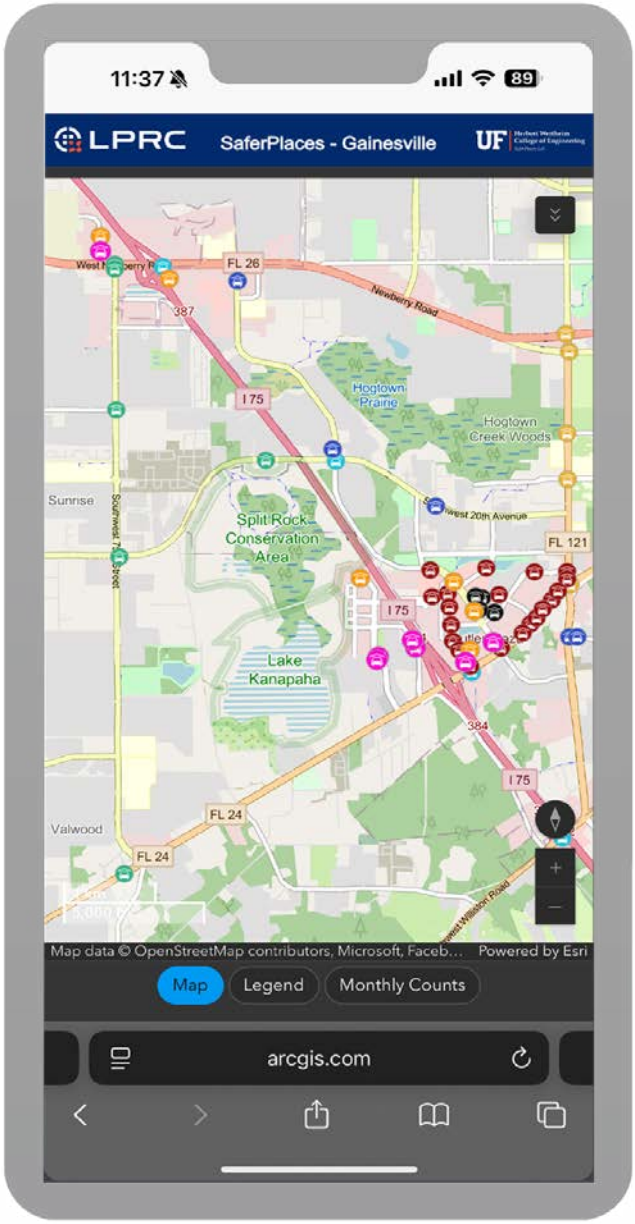
manufacturing and distribution to point of sale. Counterfeit goods now account for some 2.5 percent of global trade—more than $450 billion—while cargo theft erases $15 billion to $35 billion from the legitimate supply every year, according to the National Insurance Crime Bureau.

By applying location technology to these issues, organizations can detect patterns and uncover better ways to secure the supply chain.

In one example, manufacturers using RFID tags can log each scan along the supply chain in a geoblockchain. When viewed on GIS maps, a geoblockchain shows an audit trail of a product's journey from factory to store shelf.

That operational awareness can help manufacturers, shippers, and retailers spot where legitimate products have disappeared from the supply chain and where counterfeit products may have been introduced, pinpointing vulnerabilities in the network.





> Maps tend to have a unifying effect. When decision-makers from various business lines visualize supply chain patterns together, they often see where their priorities intersect and how they can address shared issues.

If a map of recent shipments shows a pattern of goods arriving at their destination port but failing to show up at a particular distribution center, the merchandise team might learn where containers are being diverted. Likewise, if the geoblockchain shows a cargo container leaving its port of origin but not reaching its destination port, that could indicate that goods were lost to inclement weather while on the ocean.

One key to creating this supply chain awareness is embracing technology adept at detecting patterns. For Hayes—who is also a research scientist at the University of Florida's Wertheim College of Engineering—that means getting closer to the emerging tech that fuels today's loss prevention work.

He's now using GIS technology—itself powered by machine learning—in combination with sophisticated AI models, natural language processing, and even robotics to map out and address the retail industry's challenges.

Preparing for Nontraditional Threats, Now and in the Future

Because retailers, manufacturers, and logistics providers have long used GIS software to analyze markets, plan facilities, and create efficient routes, many already have access to a key technology for identifying supply chain vulnerabilities.

Some are using location technology to prepare for nontraditional threats as well—one of which is climate change. As wildfires, extreme flooding, high heat, and drought increasingly threaten supply chain continuity, some companies are using GIS and predictive models to gauge when and where these factors could disrupt goods in transit years from now.

In today's supply chain, one innovative combination of GIS technology and smart IoT sensors is creating unprecedented levels of operational awareness. Smart shipping containers—engineered to detect everything from security breaches to elevated levels of CO_2—aim to restore confidence to manufacturers, shippers, and retailers by deterring would-be bad actors.

Back at the council, Hayes and team are studying location-based loss prevention techniques in the lab and in real-world retail environments, determined to create a safer environment for goods and people.

Retailers have "physical issues coming at them 24/7 year-round," Hayes says. "The mapping is going to help us better understand problems, better design and assess the effectiveness of what we do. . . . We're just getting started."

Operational Efficiency, Location Intelligence Yield More Security and Savings

Years ago, business executives greeted new enterprise technology with open arms, won over by promises of faster operations, connected teams, and reduced costs.

For some, those promises dissolved into a series of costly and complicated implementations.

In one of the world's great agricultural regions, a bioenergy company has defied the odds and achieved the original vision, increasing business security and generating cost savings with an enterprise technology called GIS.

The History of the Fields

A generation ago, the vast sugarcane plantations of Brazil were cut manually, with fire used as a management tool.

Today, roughly 95 percent of Brazil's sugarcane harvest is mechanized. Harvesters and their embedded technology increase crop yields while reducing worker health and safety risks and impacts on the environment. The innovation has fueled the country's rise as a global agtech leader and one of the world's most productive food pantries.

From crop treatments to harvesting to maintaining fields, location intelligence drives efficient operations—boosting safety and cost savings—across bp bioenergy, one of Brazil's largest bioenergy companies.

For bp bioenergy, a pillar of Brazil's booming sugarcane economy, GIS-generated location intelligence is an engine of efficiency. Across the enterprise, GIS has improved outcomes by increasing the safety and speed of operations.

Finding New Efficiencies

bp bioenergy manages thousands of hectares of arable land, which enables the company to produce up to 1.7 million tons of sugar per harvest, in addition to 1.7 million liters of ethanol and 1,400 gigawatt hours of electricity. Across five Brazilian states, with 11 agro-industrial units, the company uses location technology to identify opportunities for improvements to boost its efficiency.

"We are a company that operates on a large scale and we need to continue improving and innovating as much as possible, to optimize processes and costs and increase our efficiency, which are essential elements to stay in business," says Miguel Prieto, GIS coordinator at bp bioenergy.

How Location Insights Transformed Large-Scale Agriculture

Location technology now supports 23 distinct applications across the enterprise at bp bioenergy. GIS-based innovations have generated savings across the enterprise, but it all began with a friendly challenge between two colleagues.

Carlos Mondio, coordinator of agro-industrial controls, who has worked for the company for 16 years, oversees the Moema unit, one of bp bioenergy's largest production regions. Among other duties, Mondio coordinates the payments of the contractors who carry out the crop treatments in the sugarcane fields. In the

past, the company relied on these suppliers to report that jobs were completed correctly.

But as the scale of operations grew, so did the need for a centralized system to monitor costs and streamline the contracting process. Mondio asked Prieto if he could create a more efficient way of authenticating third-party work.

"How could I say no to such a challenge?" Prieto recounts.

Using GIS to track the routes of sensor-equipped tractors and planes, Mondio and team verified the movements of the third-party providers. With the accountability gained through location awareness, they've reduced operational costs by 7 percent.

High-Precision Farming, Guided by GIS

Before long, another colleague came knocking on Prieto's door with a task that is at the heart of bp bioenergy's operations: optimizing the harvest.

Harvesting sugarcane involves a carousel of movement. A harvester travels down a length of field, cutting cane billets and feeding the crop into the empty bed of an attached tractor or truck. When the truck is full, the harvester detaches from it and picks up an empty truck, while the full one is transported to the mill and unloaded.

> The number of harvesters required to do the same work dropped to 120 from 223, while the tons of sugarcane harvested per day rose to 985 from 580.

When this cycle is multiplied across hundreds of crews and fields, delays and wasted movement can pile up. For Mário Salani Junior, a mechanization manager at bp bioenergy, this was a process ripe for innovation. He reached out to Prieto, and within a week, the GIS coordinator had developed a pilot solution.

Using sophisticated analytics, the GIS app improves routing and positioning of tractors, making the harvest faster and more efficient. Planners can predetermine the ideal entrance and exit areas for harvesters and identify the best transfer points for sugarcane loads, eliminating wasted time and motion. "With this technology, you prove that these are the best decisions," Salani says.

Location insights along with other innovations have helped bp bioenergy decrease costs while increasing efficiency. Since 2019, the number of harvesters required to do the same work has dropped to 120 from 223, while the tons of sugarcane harvested per day rose to 985 from 580.

> "It's a technology we can really apply in our processes day-by-day . . . to be more safe, reduce the costs, and be more efficient"
>
> -Mário Salani Junior, bp bioenergy

With the routing efficiency introduced by location technology, the company was also able to reduce fuel consumption and therefore emissions. It's a trend seen in other industries as well: By streamlining truck deliveries or service routes with GIS, emissions and costs fall while efficiency increases.

Rising Demand for Spatial Context Across the Enterprise

As the value of GIS gained recognition at bp bioenergy, new opportunities for location solutions arose across the enterprise. Location technology supports worker safety, for instance, by showing emergency responders the quickest routes in case of field incidents.

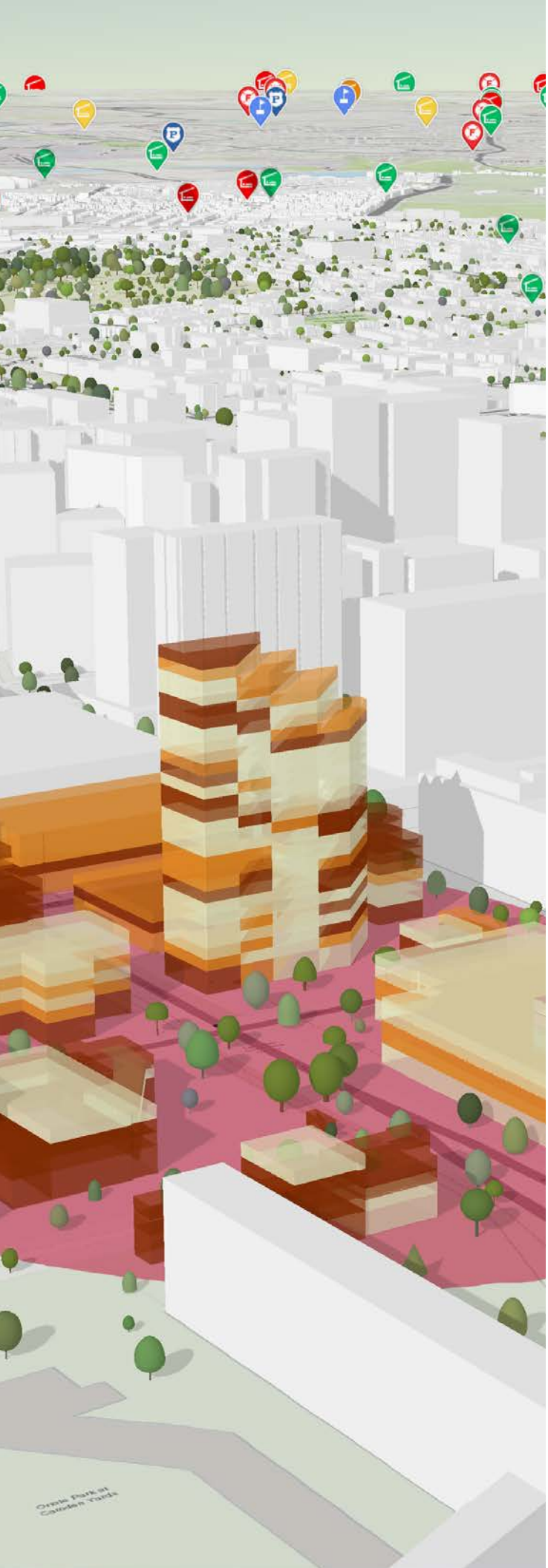
That's just one benefit of mapping the thousands of miles of private roads that crisscross the company's properties. At bp bioenergy, the geometry of over 34,000 sugarcane fields changes on a near-daily basis as new areas are added or harvest cycles conclude. In the past, these changes were tracked manually, one at a time.

Now, GIS maps update the dimensions of cropland in real time, aiding decision-making throughout the enterprise. "They need to know precisely the area every day to make payments, do planning, to know how much they'll be harvesting, how much fertilizer they're buying, how many plants," Mondio explains.

With the years ahead predicted to bring even greater growth in Brazil's agriculture sector, bp bioenergy is positioned to unlock even greater value across the enterprise through GIS.

Enriching Data, Analytics, and Apps

The data-driven transformation that swept through organizations in the 2010s delivered valuable insights but often missed a crucial dimension: where things happen. Forward-thinking organizations and leaders are now discovering that adding geographic context to their data analytics–mapping customer behavior, supply chain bottlenecks, or market opportunities–reveals patterns and insights that traditional business intelligence overlooks.



Enriching Data, Analytics, and Apps (continued)

A datacentric organization mines evidence from the past and present to read signals of the future. Piloted by a chief data or analytics officer and backed by a team of analysts, these firms dissect data from enterprise systems and outside vendors to understand economic trends, demographic shifts, and the operational performance of the business.

But some industry leaders have graduated to a deeper level of analysis—by enriching data with location intelligence. Only then does business intelligence reach its full potential, showing executives where stores are outperforming revenue targets, which markets are shifting toward a younger clientele, and how to reconfigure a distribution network to reduce costs.

Achieving a higher form of business intelligence demands a blend of art and science—setting a collaborative tone for data scientists and location analysts, while supplying them with the right tools.

Often, the tool is mapping and analytics software—technology nimble enough to integrate with a data lake and analyze organizational KPIs. For other businesses it's precision geocoding—a capability that improves operational efficiency by guiding delivery drivers to loading docks, home health aides to clients, and apartment hunters to available units.

For millions of apartment hunters using the Rently app, location precision could be key to finding their next home. With an app powered by location services, Rently simplifies what might otherwise be a disorienting experience, helping applicants find the right parking area, building, and unit in large multifamily developments.

Location awareness allows millions of bikers, runners, climbers, and wanderers using the Relive app to track their routes, navigating with the help of 3D maps. When they're done, they share their journey with friends or relive it themselves, creating a location-rich scrapbook of where they've been and who they are.

For companies that aspire to be datacentric, the takeaway is clear: True business intelligence emerges when everyone—the company and its customers—knows where they stand.

One Proptech Standout Expanded for Years, Then Harnessed Location Intelligence to Kick-Start a New Stage of Growth

A decade ago, investments in proptech—technology aimed at making real estate easier and more efficient for buyers and sellers to navigate—could be measured in the tens of millions.

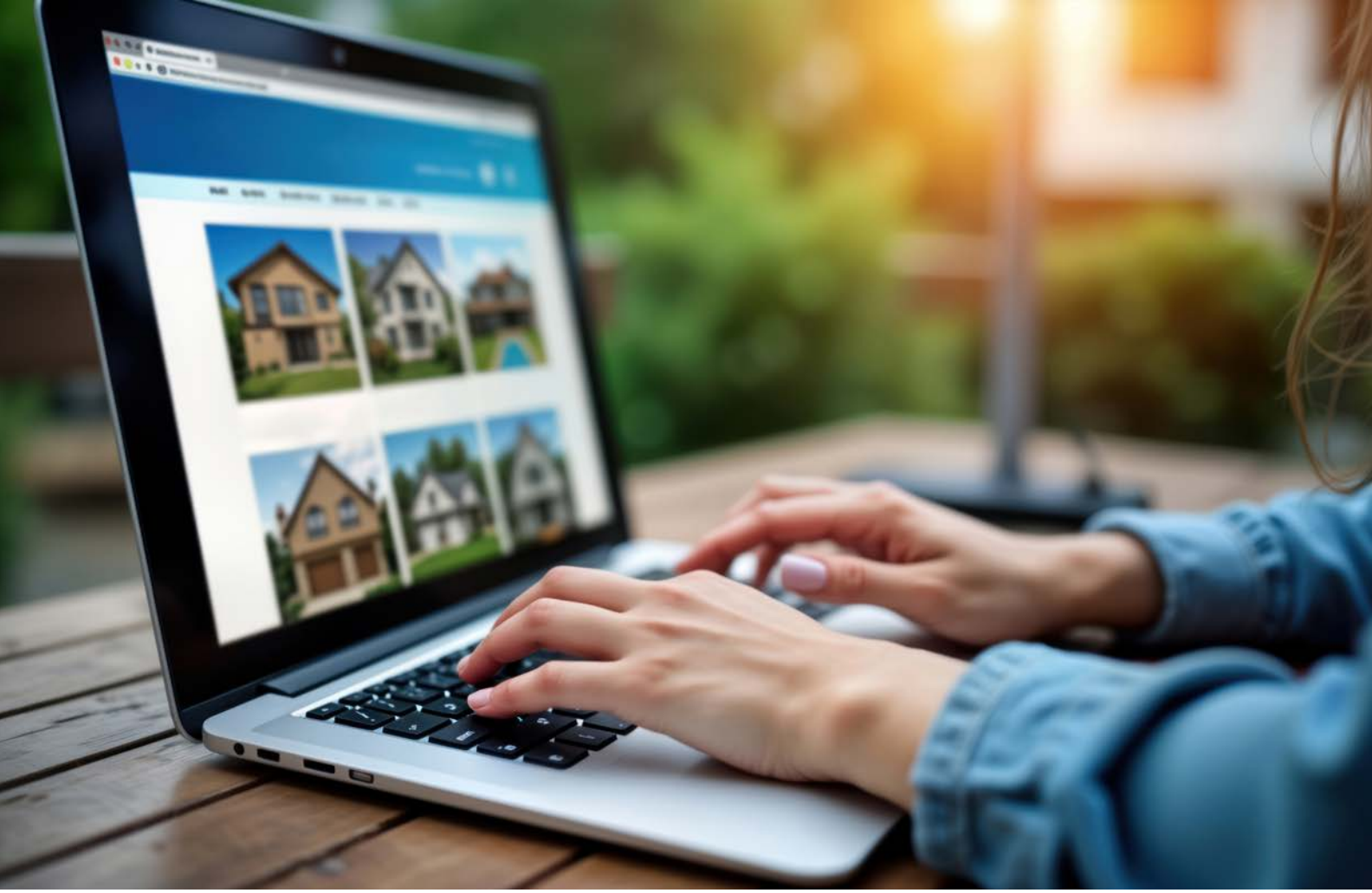
As the ranks of proptech startups swelled and software advanced, investors responded, pouring $13.4 billion into the sector in 2023, tempted by the chance to disrupt the world's largest asset class. Yet even in a market that's grown this big, sometimes the most impactful innovations are measured in the smallest increments.

For proptech pioneer Rently, which orchestrates self-guided tours for the rental industry, a surge of demand landed on the company's doorstep with little warning. It might have overwhelmed some companies, but by integrating a precision form of location intelligence into its platform, Rently turned the business challenge into an opportunity to fuel a new era of growth.

Rently's Quest to Put Apartment Hunters on the Right Path

Founded in 2011, Rently offers a system of smart locks and secure ID verification that enables prospective renters to visit properties without assistance from leasing agents, a process known as self-guided touring.

The founders' aim was both to liberate management staff from the time constraints of touring and to allow people looking for an apartment to view units on their own schedules. The business quickly grew among owners and renters of single-family



homes. Within a few years of its launch, Rently could count some of the nation's largest property owners and real estate technology firms as customers.

> Rently set out to help apartment renters tour communities without getting lost. In the process, the proptech company enlisted GIS technology to navigate a new stage of growth.

By 2016, Rently's leaders were eyeing the next major opportunity for self-guided touring: multifamily developments such as condominiums and apartment communities, often owned by real estate investment trusts (REITs) that generate income off large portfolios of properties. Rently began by selling smart home devices like sensors and alarms to owners, while sizing up the right moment to break in with self-touring technology. Then, almost overnight, COVID-19 changed everything.

With the onset of the pandemic, rental demand in the suburbs and exurbs soared. Owners of multifamily developments were suddenly drawing as many as 50 new tenants a week. For property managers that had typically used leasing agents to handle renter visits, contactless tours became the safest way to conduct business.

Over a thousand new owners of multifamily properties signed up for Rently—a welcome expansion, but one that raised a new challenge. For single-family homes, self-touring renters could find the right property with a simple street address. Renters visiting multifamily apartment complexes had to wander through a maze of buildings, common areas, floors, and doors without assistance from agents.

A New Level of Mapping Accuracy and Convenience

For Jared East, Rently's vice president of product, a chance meeting at the Apartmentalize Conference with members of location intelligence company Beans.ai catalyzed a solution.

With GIS software at the core of its technology, Beans.ai uses machine learning, lidar scans, and other

tools to generate digital maps that are hyper-accurate to within a few feet. Their location technology is employed by organizations requiring precise directions to doorsteps, from delivery companies to firefighters.

When East met the Beans.ai team, he suspected he'd found the key to fast, cost-effective mapping and wayfinding. But to win the trust of company executives, he wanted to prove it. Rently's product designers worked closely with Beans.ai counterparts to fine-tune the wayfinding technology and test it in pilots. The feedback was immediate: The technology streamlined the rental process for managers.

With Rently executives on board, East and team integrated the sub-address-level geocoding capabilities and began mapping apartment complexes with GIS.

Rently's navigation technology, accessible via mobile devices, helps self-touring visitors find the nearest parking location; follow the most efficient route between multiple units; and navigate to amenities like dog parks, gyms, and swimming pools.

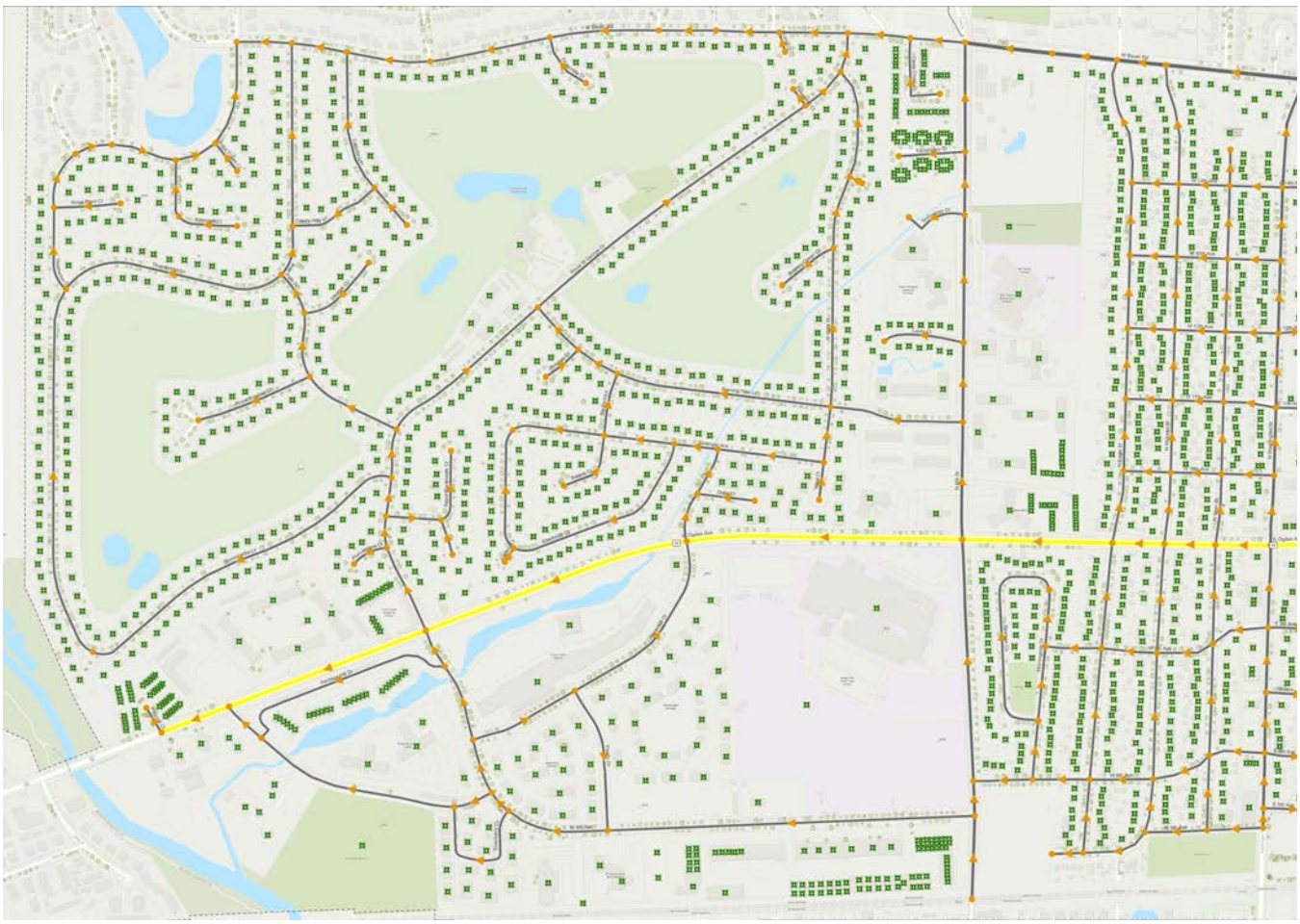
"That's helped us grow tremendously in this last year," East says. Completed tour conversions rose by 20 percent and the number of tours per community increased as well.

In addition, the time required for property managers to set up a tour dropped from 45 minutes to less than a minute, according to Rently. "It's helped them capture more business hours in order to turn more profits and lease more units," East says.

Growing Demand for Precise Location Intelligence

As demand for precise geospatial data grows across industries, applications for GIS in indoor spaces are multiplying. Wayfinding applications powered by location technology have helped university students navigate labyrinthine school buildings and enabled scientists to implement hoteling at a national lab so important work could continue during the pandemic.

When it comes to navigating apartment complexes, the lack of precision in traditional online maps



has long bedeviled delivery drivers, not to mention paramedics and police who can lose precious minutes trying to reach residents in need. In the proptech world, solving the navigation problem for renters became an opportunity for competitive differentiation.

A typical apartment community, for example, might encompass 16 buildings, each with several floors and multiple entrances, as well as parking lots, staircases, and elevator banks. If a renter types the address of the community into a typical online map service, a pin appears at random in a multiple-block campus.

East, who got his start at Rently when the founders were still working from a picnic table, remembers when the location problem in multifamily properties was a barrier to growth.

> Harnessing micro-location intelligence saved property managers hours of time, increased bookings, and improved renter satisfaction, ultimately helping Rently expand into the multifamily business.

Initially, Rently addressed the issue by annotating slideshows with pictures that demonstrated how to find a unit and smart lock for a self-guided tour.

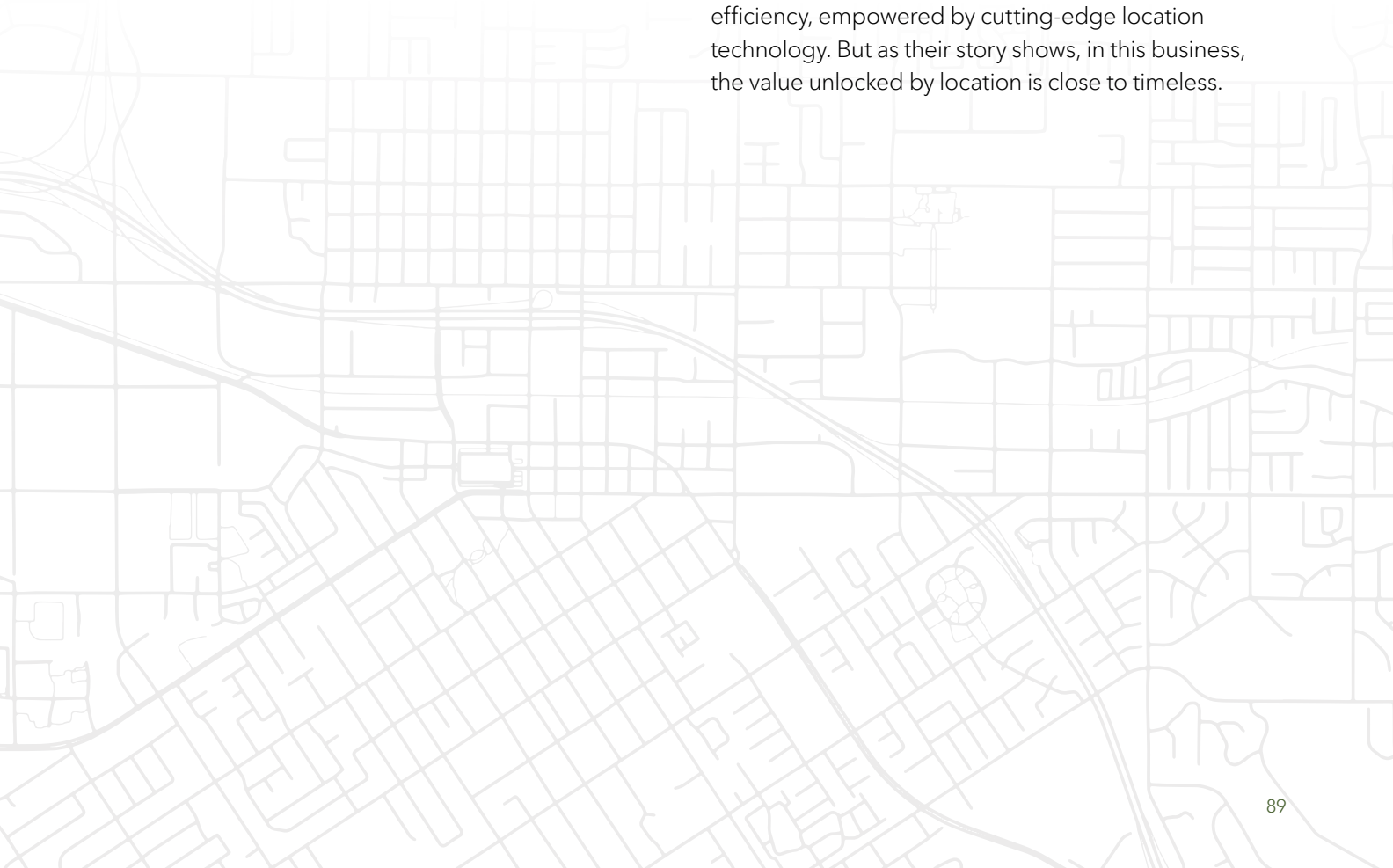
COVID-19 spurred a surge in multifamily property rentals that was so fast, Rently staffers felt like they were building an airplane in flight. Developing slideshows for hundreds of new customers wasn't feasible, and the traditional mapping providers Rently contacted were too costly and slow.

"If we wanted to hit the growth numbers we want, we needed to get these maps out in days, not weeks," East says. Integrating precision-guided location intelligence helped make that pace possible.

As Tech Evolves, Value and Location Remain Interlinked

As of summer 2024, over 3,000 multifamily properties on Rently are equipped with GIS-guided wayfinding technology. A new feature allows renters to search apartment community maps before they even start touring to assess how a unit's location might suit their needs.

Proptech innovators like Rently are remaking the rental business with new forms of convenience and efficiency, empowered by cutting-edge location technology. But as their story shows, in this business, the value unlocked by location is close to timeless.



For Millions of Adventurers, Relive App Makes Location Data More Human

As Emmett Ball rode the ferry from Oakland to San Francisco, he thought about how far he had come. He was 1,200 miles into a bike tour that had begun at the Canadian border. He'd followed Highways 1 and 101 down the US Pacific coast, cycling through cities and along the ocean, sleeping in state parks and dining on camp-cooked rice. When he stepped off the ferry in San Francisco to begin pedaling again, he was still more than 600 miles from his destination.

By then his memories had blurred—one campground ran into the next, and each meal tasted like the last. But the 22-year-old University of Montana grad didn't mind. After six weeks of cycling, he had answered one of the big questions motivating his trip—whether he could physically handle a supersized trek. And he was having the experience of a lifetime. Career decisions could wait until he returned. For now, he was slowing down, bucking routine, and embracing adventure.

"I thought it would be cool to see [the country] each day morphing as I traveled through," Ball says of his nearly 2,000-mile bike tour from the Canadian border to the Mexican line.

And even though he couldn't remember exactly how many hills he'd conquered since Tuesday or where he'd eaten dinner on Friday, he had something that did—a modern-day, location-based travelogue that was capturing his trip and giving loved ones a glimpse of his life on the road.

Relive App Helps Preserve the Journey

Each morning as Ball set off on another rolling spin class, he opened the Relive app on his phone and began tracking the day's 40- to 60-mile trek.

At least, that was the idea. "It's not uncommon to just start the day rolling and then get three to five miles down the road and [realize] 'Oh, whoops, I've got to find a place to pull over because I've got to turn this tracker on,'" Ball says.

The app captured key aspects of his two-month odyssey and made them accessible to family and friends. "I wanted to keep people in the loop and wanted to share my experience," he says. He just didn't want to spend hours updating a blog or writing emails.

Through the Relive app, Ball shared a 3D animation of each day's journey, complete with photos he had taken along the way. If he took a picture while he cycled through a tunnel of redwood trees, it showed up in the right location on the map. If he wanted to relive the agony of climbing the hills outside Leggett and Crescent City, California, he could replay the 3D video and marvel at the unforgiving slopes.

Ball liked the way the app told the story of his journey—simply, visually, and geographically.

Borrowing from the GIS Platform

Ball isn't alone. While the world had its fair share of outdoor enthusiasts before the COVID-19 pandemic, the global health crisis chased many more out into nature. Each enthusiast defines adventure differently, but whether it means long bike rides, afternoon fishing trips, mountain trail runs, or walks on the beach with the family dog, most experiences create memories worth keeping.

Thirteen million people around the world use Relive to capture those memories.

"I think it's just cool that it's such a vehicle for telling stories, and that everyone is going to tell their story different," Ball says.

To power those stories, the startup company behind the Relive app uses technology called GIS. But six years ago, when Relive was just an idea, none of its cofounders knew which technology could bring the app to life. Yousef El-Dardiry, one of the three cofounders and the primary architect of Relive, had never heard of GIS software. A chance encounter with an expert in the technology changed that.

> When an epic bike ride sent three friends searching for a better way to memorialize their adventures, the idea for a Relive app was born. When the team integrated GIS functionality into the app, it became a worldwide phenomenon.

El-Dardiry soon learned that he could integrate select services from a GIS platform into the Relive app. That included satellite imagery of the earth's terrain, elevation maps, SDKs for building functionality, and APIs for integration.

As El-Dardiry explains now, "We are a very engineering-heavy company. . . . We're not interested necessarily in having a one-size-fits-all solution, because we're building something new. So [we're looking for] a mix-or-match fit."

By incorporating GIS-based location services and 3D maps into the app, Relive helped users capture realistic animations of their adventures.

"The map is the best way to really visualize your outdoor story," El-Dardiry told *WhereNext*. "To turn it into a visual, compelling story, the map forms the centerpiece."

An Ambitious Climb Yields Unexpected Inspiration

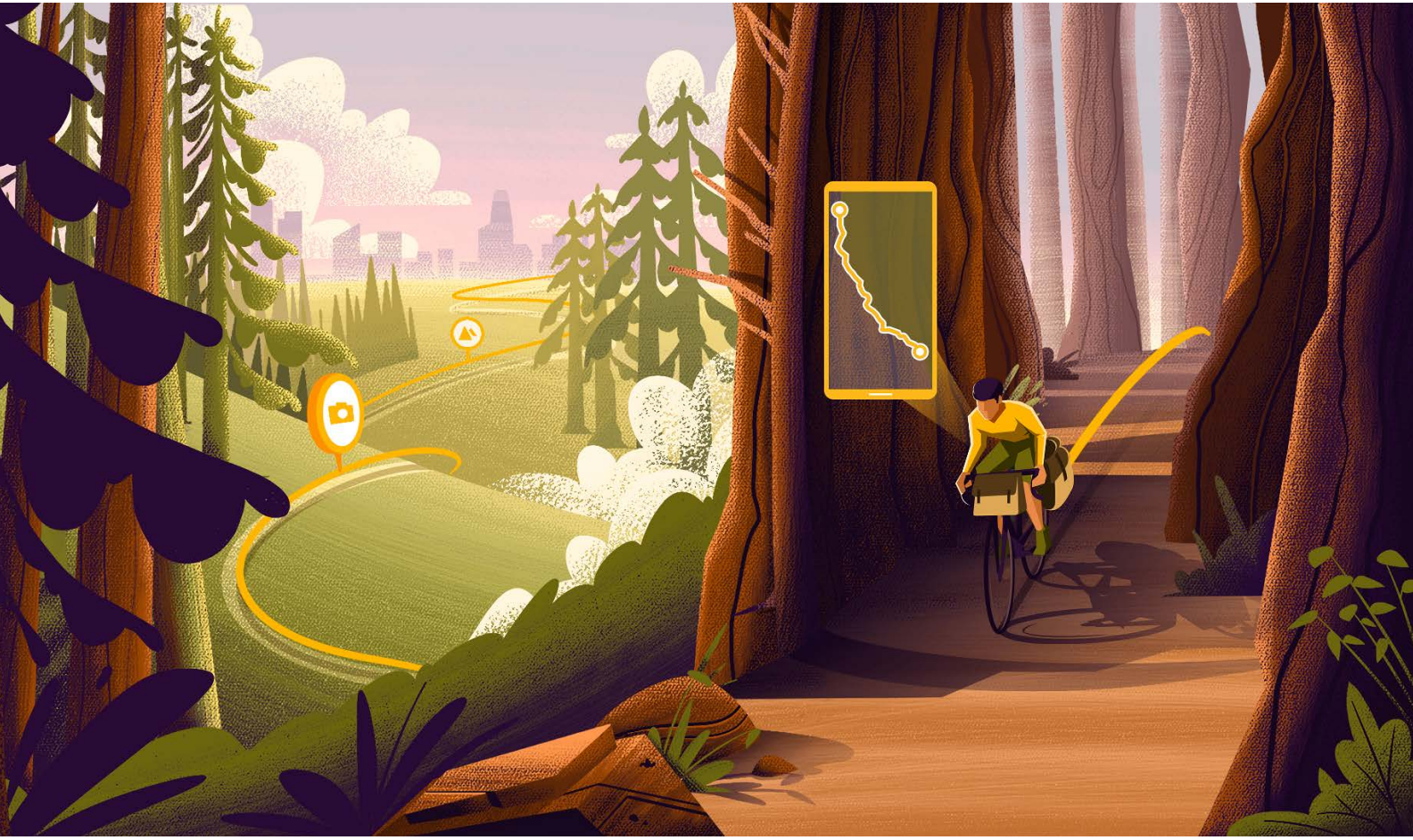
Many tech companies—including Apple and HP—trace their roots to their founders' garages. Relive was born on a volcano.

In late 2015, El-Dardiry and seven friends—all in their thirties, all former engineering classmates at Holland's Delft University of Technology—decided to do something many observers would consider foolhardy. Having taken up road cycling earlier that year in their home country—one of the flattest on earth—the group of eight decided to cycle up a 3,715-meter (12,188-foot) mountain in the Canary Islands.

They tried their best to prepare.

"We did a weekend somewhere in the south of the Netherlands where it's kind of hilly, but the biggest hill there is like 200 meters," El-Dardiry explains.

Their next stop was off the coast of Morocco: Mount Teide, a dormant volcano on Tenerife, the largest of the Canary Islands. In December, the eight friends rented a house



on the island and spent four days cycling its roads, getting acclimated for the big climb. Their bikes were adorned with gadgets—cycling computers and mobile phones that tracked their distance, pace, heart rate, and practically anything else that could be measured.

> "The app—and specifically tracking myself geospatially—really helped me . . . digest what the city was, almost. Having the tool really helped me feel oriented"
>
> -Emmett Ball

"We were kind of geeking out on all the numbers and all the stats," El-Dardiry says. "That, for us, was super cool."

Then came the crescendo—the trip up Mount Teide.

"We were all maybe a little bit nervous and eating way too much pasta the night before," El-Dardiry remembers.

On the morning of the ascent, they dipped their bike tires in the ocean, gathered on the road, and began the climb. El-Dardiry remembers the camaraderie of the ride and the skirmishes that broke out as friends tried to overtake each other on the hill. "Some kilometers later, all energy is out and you still have to go to the top," he recalls ruefully.

For new road bikers from a flat country, they were holding their own. But the climb seemed unending, and it took its toll. When they finally reached the top, some members of the group were nearly in tears from the effort. It had taken many hours and all their reserves, but they had reached their goal. As they enjoyed Mount Teide's long descent, night fell over Tenerife. El-Dardiry calls it "one of the most epic days of our lives," an experience rich with pride, pain, and memories.

"Then, when you look down at your device or your app, you see something like 100 kilometers and 3,000 meters elevation gain. All these stories . . . were all compressed into numbers," he says. "We realized, 'Hey, something is missing.'"

They wanted to remember the roadside restaurant where they enjoyed a beer, and the barbeque dinner they devoured at the end of the long day. They wanted to remember the feeling of standing triumphantly on the summit. But none of those sights lived in a number, or even a two-dimensional map of their route.

For the Tenerife eight—and millions of people around the world—the goal wasn't to collect more data. It was to make the data more human.

"We really enjoyed being active and enjoying the healthy lifestyle, but also just having a good time with friends," El-Dardiry says today. "So we wanted to build something that would capture more of that experience and allow us to share [it] with other people."

Engineers being engineers, El-Dardiry, Lex Daniels, and Joris van Kruijssen decided to build the solution they envisioned. Before they left the Canaries in December 2015, the idea of Relive had been born.

A Platform for Every Journey

As Emmett Ball wheeled down the US Pacific coast in summer 2021, the Relive app captured his travels. Each evening—often by a campfire in a state park—he opened the app, labeled the day's ride, and within five minutes had shared the video with family and friends.

His parents enjoyed the animations of his route, and nudged him to take more pictures. His grandmother "liked" his posts and comments.

"It's cool to use it as a family update device," Ball says. "It lets people stay in touch with you—almost paradoxically—from a distance."

What family members saw in his Relive pictures and 3D maps was a tapestry of terrain. Although the Pacific coast bicycle route sounds like an oceanside idyll, it is in fact a remarkably varied experience. Riders pass through intertidal zones and old growth forests, agricultural oases and deserts, and major cities like San Francisco and Los Angeles.

Ball saw variety in the people he met, too—everyone from young wanderers like himself to older couples riding tandem bikes. There was camaraderie in their encounters, and transience, too.

"Some people you'll meet, and you'll see them every day for a week, and then somehow you just get a little off track between each other, and then you never see them again. It's funny that way."

Ball counts many highlights from his journey, but his passage through California's Bay Area made a special impression. Those two days were a cocktail of wonder, reflection, and exploration, and the Relive app played a role in celebrating it.

As he biked south through Berkeley toward Oakland, Ball used the app to orient himself and ensure he made it through the urban center to the ferry. Later, he watched a 3D animation of his trip around the bay. Clicking on pictures he had taken, he could see the weather change on a short ferry ride—from the

clear skies near Alameda Island to the clouds roiling the sky over the Golden Gate Bridge. He thought about the topography of the place, and how it made San Francisco a choice spot for a thriving city.

"That day I remember feeling like the app—and specifically tracking myself geospatially—really helped me digest what I was actually looking at and digest what the city was, almost. Having the tool really helped me feel oriented," Ball says.

The Relive app preserved many nuances of his time on the road: The people who shared water or stories along the way. The white-knuckle ride over the five-mile Astoria-Megler Bridge into Oregon. Pedaling silently beneath 300-foot trees.

"I think the record will kind of stand on the app," he says. "And it will be cool to see how my perspective changes on it as I revisit the journey, as the years go by."

Location Services Enhance Human Experiences

The Relive team's experience building an app for Emmett Ball and 13 million users tells several lessons—some technological, some human.

In technological terms, adding map features to an app is now a mix-and-match endeavor, as El-Dardiry puts it. Startups and established companies alike can use GIS functionality to add location intelligence to their apps.

Those apps, in turn, can amplify the experiences people crave. Since Relive launched in 2016, it has expanded from a tool to track cycling trips to a companion for all kinds of outings—motorcycle trips, skiing adventures, marathon training sessions, and more. Each use of the app blends stories and data, and addresses a common human need: to understand and remember our paths through the world.

"You can see from all the feedback we've been getting [from] users that they really have an emotional connection with the content that they create with the app," El-Dardiry says. "That's quite something."

It harkens back to the emotion he felt pedaling up a volcano with good friends. And it proves that the best ideas sometimes emerge while you're doing something else—or when you're headed in another direction.

Making the App More Human, and Rolling Along

El-Dardiry, Daniels, and van Kruijssen were on different career paths when their mountainside inspiration struck in 2015. Within weeks, they had begun charting a new course together.

The friends spent months creating a tool they would use for their own excursions. Once they'd refined the early version into something they could use, they wondered if others might use Relive, too.

In April 2016, El-Dardiry, Daniels, and van Kruijssen shared the app with their fellow volcano climbers and invited them to share it with their friends. Within a week, more than 1,000 people were using Relive. Within a month, 10,000.

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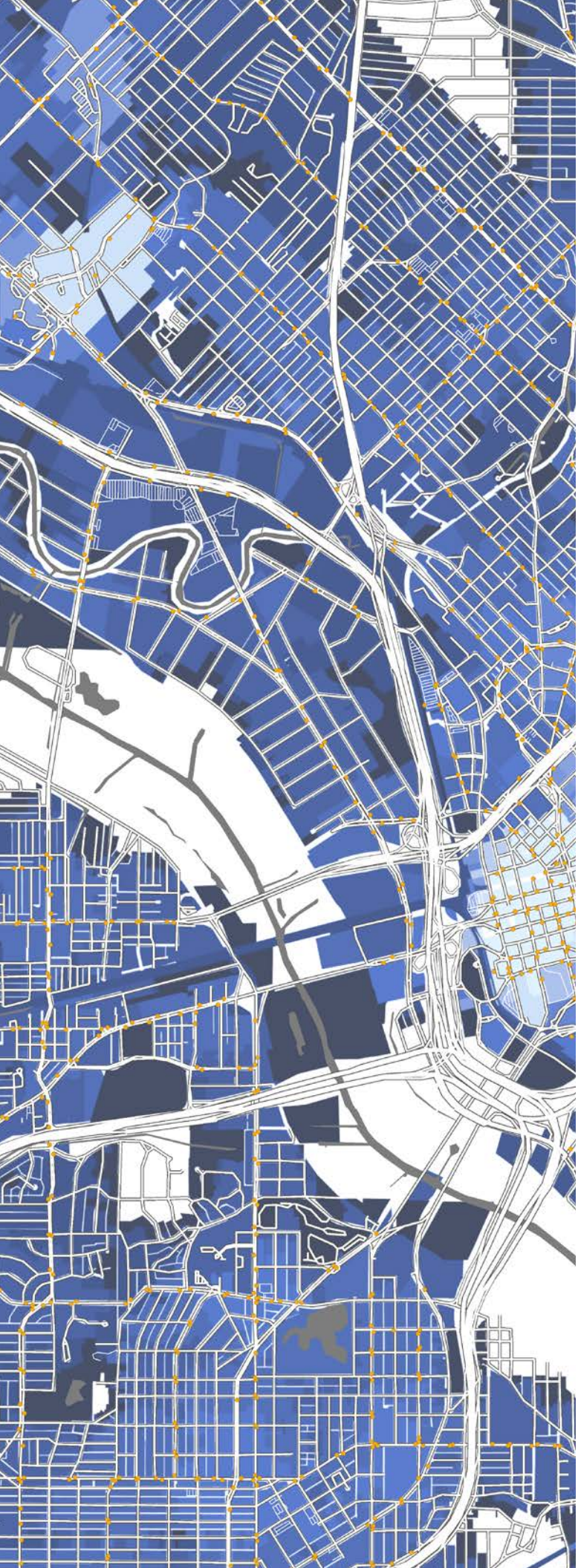
>
> -Yousef El-Dardiry, Relive

Feedback was easy to find on social media. Users seemed to love watching the animations—seeing how the landscape had changed during each adventure, and sometimes seeing how it had changed them. They posted Relive animated videos on Facebook, Twitter, and other platforms, sharing memories of their journeys.

As El-Dardiry, Daniels, and van Kruijssen watched the growing momentum, they started to feel like their startup was rolling down a mountain.

Five years and 13 million users later, Emmett Ball opened his phone near the Canadian border, started the Relive app, and pointed his bike toward Mexico.



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Esri, the global market leader in geographic information system (GIS) software, location intelligence, and mapping, helps customers unlock the full potential of data to improve operational and business results. Founded in 1969 in Redlands, California, USA, Esri software is deployed in hundreds of thousands of organizations globally, including Fortune 500 companies, government agencies, nonprofit institutions, and universities. Esri has regional offices, international distributors, and partners providing local support in over 100 countries on six continents. With its pioneering commitment to geospatial technology and analytics, Esri engineers the most innovative solutions that leverage a geographic approach to solving some of the world's most complex problems by placing them in the crucial context of location.

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