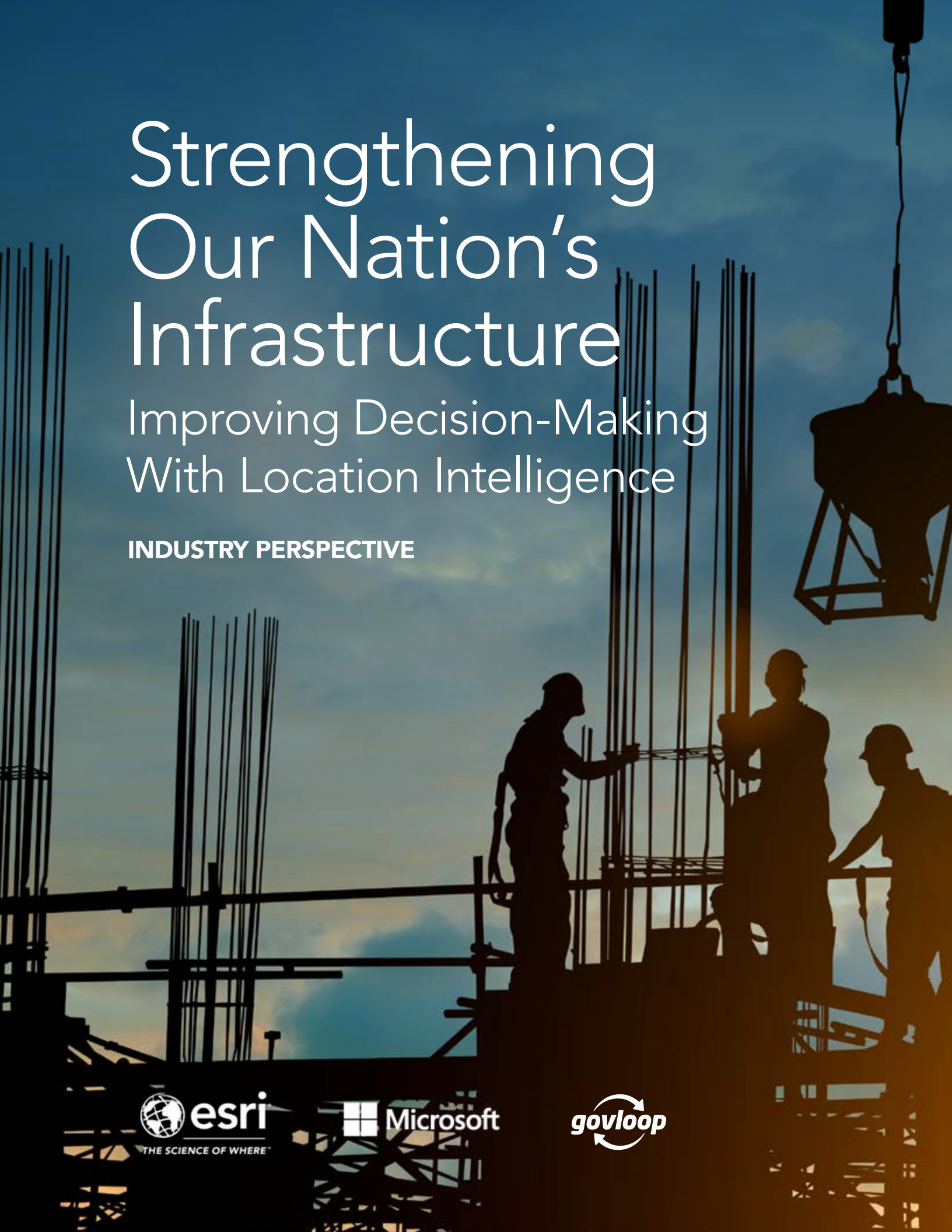


Strengthening Our Nation's Infrastructure

Improving Decision-Making With Location Intelligence

INDUSTRY PERSPECTIVE

esri
THE SCIENCE OF WHERE

Microsoft

govloop

In 2017, the unthinkable happened: A massive fire set by three individuals caused the collapse of a 100-foot section of an I-85 bridge in Atlanta. Motorists were stranded for hours, backed up for miles in each direction and repairs were predicted to take months.

The repairs to this infrastructure would impact the whole region: Georgia Department of Transportation's data for a spot on I-85 slightly south of the collapse showed 243,000 vehicles traveled there daily. A 2012 estimate said the bridge itself carried approximately 199,160 vehicles a day in both directions.

The I-85 collapse was only one of a series of high-profile infrastructure failures that have resulted in complications and injuries across the United States in the past years. But not much has changed when it comes to the crumbling state of America's infrastructure.

How can state and local governments address aging infrastructure in a way that will truly make a difference today and in the future?

The answer lies in not just rebuilding our infrastructure. **Communities need to rethink and reimagine the possibilities of infrastructure for the future as well.** Geographic information system (GIS) capabilities can help communities restore the nation's vast system of transportation, water, sewer and telecommunications networks.

To better understand how, Esri, a leader in GIS, Microsoft, a leader in cloud-based services, and GovLoop partnered for this industry perspective. This report will dive into how communities can use GIS to rebuild infrastructure to maximize investments, rethink current infrastructure to meet socioeconomic needs and changing lifestyles and reimagine ideas around an internet of things (IoT)-driven, future-ready city with infrastructure that can support the future and beyond.

The Current State of Our Nation's Infrastructure

America's Troubled Infrastructure by the Numbers:

Bridges: **One in nine** of the nation's 607,380 bridges is rated structurally deficient, and the average age of a bridge is 42 years.

The America Society of Civil Engineers (ASCE) estimates that **32 percent** of major U.S. roadways are in poor or mediocre condition, costing each driver an estimated $324 per year in additional repair and operating costs.

The size of international cargo ships is **rapidly increasing**, but only a very small number of the 300 commercial ports and harbors in the U.S. can accommodate the larger "post-Panamax" vessels that will increasingly handle the majority of international shipments.

Kevin M. Burke, President and CEO of Airports Council International, North America, has said **virtually all** U.S. airports are overdue for major structural improvement projects. Our airports are aging, he told us, and because of budgetary restrictions, they're not aging well.

To understand how to rebuild and reinvest in infrastructure for the future, we must first understand the past and the present, and how the United States came to face an infrastructure issue of this magnitude.

The American Society of Civil Engineers (ASCE) released its 2017 report card of U.S. infrastructure. The country's transportation networks received an overall letter grade of D+.

The ASCE estimates that the U.S. would need to invest $4.9 trillion over the next decade to restore infrastructure to relative health (a B+ grade) – up from $3.6 trillion in the previous report card year of 2013. If the infrastructure funding gap is not swiftly addressed, the U.S. could suffer $7 trillion in lost business by 2025, and 2.5 million lost jobs.

But communities suffer from being stuck in a particular mindset when it comes to infrastructure – one of repair and retrofitting. The main goal of today's infrastructure budgets is to repair existing crumbling infrastructure. Instead of retrofitting infrastructure to the way it was built 10, 20 or even 100 years ago, they need to discover the possibilities inherent in infrastructure for their communities of the future.

Informed Decision-Making Leads to Smart Infrastructure Investments

Effectively addressing our infrastructure needs begins with knowing where to make the most strategic investments. A successful plan to restore America's infrastructure will require effective management of these investments.

GIS technology help us better understand where and how we should invest in our transportation, water, sewer and other utilities. With GIS, we can see which areas are most affected by aging infrastructure or not meeting demand levels, or shifts in demographics and target dollars accordingly to deliver the greatest impact.

GIS is an essential foundation for government planning and decision-making. It is a system of record that helps government better manage infrastructure projects and measure their impact, as well as a platform of engagement that lets leaders demonstrate return on investment and share information with constituents.

But it's not just about recovering delayed maintenance projects. GIS helps governments understand what their infrastructure will look like in the future based on technological advances and changing lifestyles.

Using GIS to look at current and future infrastructure marks the beginning of a new era where GIS data and analysis helps build a government that is more responsive, efficient, transparent and engaged. Communities need to learn to think GIS first to drive long-term decision-making and planning by implementing data-driven decisions and collaboration with geodesign.

3 Ways GIS Can Strengthen Our Nation's Infrastructure

By approaching infrastructure challenges with GIS, governments can **rebuild** with priority to maximize investments; **rethink** current infrastructure to meet socioeconomic needs and changing lifestyles and **reimagine** their ideas around an internet of things-driven, future-ready community.

#1 Rebuild

To improve infrastructure, governments must generate community buy-in and agree on a common framework for new projects – all while taking into account short-term and potential long-term needs and changes in infrastructure and maintenance plans.

Rebuilding a community's infrastructure means taking into consideration what needs repair immediately – but also how those many infrastructure issues need to be addressed and in what order. What is the priority of these infrastructure issues? Which is the most urgent? Which would have the most immediate impact on a community or a population?

In short, communities must understand current conditions to better prioritize projects.

Governments today can use prioritization models to decide which projects to focus on by using GIS and existing data. The models, along with citizen feedback, can be used to justify decisions about where and how infrastructure changes and upgrades will be implemented.

With GIS, agencies can organize and use data related to population density, traffic data, consumption and capacity, and business permits to target highly problematic infrastructure spots before it's too late.

Rebuilding in Action: Redlands, CA

The challenge: Redlands, a city of about 70,000 in Southern California, had a problem: Many if not all of its downtown roads were desperately in need of resurfacing.

"As in many communities, we had a need for resurfacing many of our streets. And it was something that was put on the backlog for many, many years," said Mike Pool, Civil Engineer for the city of Redlands. "We have 640 lane miles of streets. How can you pick and choose where to start? We had to figure out the best approach to use in order to fulfill the obligation of trying to pave streets at a decent rate."

The solution: Pool and his team turned to GIS data and visualization in order to prioritize which streets would be paved with the resources they had, and in what order.

"We broke our prioritization strategy down to 11 separate criteria, many of which involved a GIS aspect," he said. "One of them was a physical observation of streets based on data that we were able to achieve from GIS. And then, with that, we also had other categories such as average daily traffic, population, school and health facility, commercial property, the street type, whether it be a local, arterial or minor or major street, and then the pavement condition index, which is also given to us through GIS-related data." Other criteria involved data like where bike lines were located, where bus routes went and where new rail stops might go in.

The result? Two-thirds of all streets have been prioritized and paved so far, and now Pool has the data and visuals to show others the reason for the delay of repaving on their street.

"It's been well received and I'm proud to be part of such a thing we were able to get our streets to a point that we've improved them much better than what they were before," he said.

A screenshot of the Redlands Pavement Management Program, from cityofredlands.org

#2 Rethink

Today, communities have followed processes that got them into plain "repair and rebuild" mode as opposed to rethinking what they are doing.

But what happens 10 or 15 years down the road, when needs and demographic data are shifting so quickly and therefore affecting infrastructure and planning needs?

Communities need to rethink their infrastructure futures and decisions, not just react and rebuild. People are constantly and inevitably changing their patterns and the way they live. So communities must focus their infrastructure priorities to project the next potential models of infrastructure their community could need.

For example: Does your community continue to build roads because there is an assumption that everyone drives, or are you considering switching to focus on multi-modal because millennials are using public transit and rideshare, and the needs of your community will be very different a decade from now?

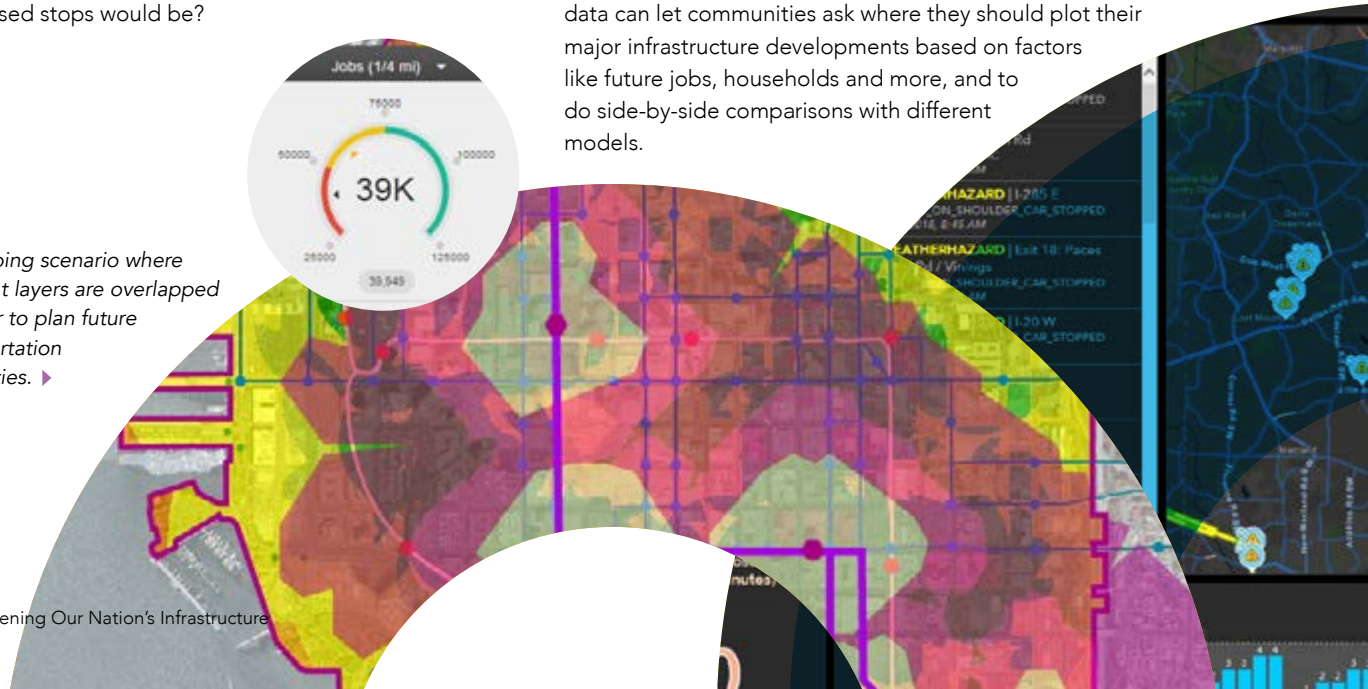
That's what rethinking is all about – using GIS and geodesign to plan appropriately for the future based on current and future lifestyles of your shifting population.

Rethinking in Action: Planning a City's Transportation for the Future

The challenge: What does rethinking look like? In one scenario, it could be a city trying to predict how its residents will get to work – as far ahead as the year 2050. But envisioning the kind of ways and modalities of transportation available at that point can be difficult. It can also be difficult to plan significant infrastructure developments to serve a population that, 30 years from now, may look and live entirely differently than it does today. This is the challenge many communities are facing when deciding where to build new transit stops or routes. How could they best project where the most efficient and most-used stops would be?

The solution: Using GIS to project population changes, economic growth, households and other changing demographic solutions, a city can create a model of where it wants future public transportation stops to be developed. This model can ensure that the regional transportation planning process relies on forecasting tools that will adapt to new socioeconomic environments and emerging planning challenges.

Using GIS to rethink future modalities of infrastructure and transportation is a natural choice. GIS platforms and data can let communities ask where they should plot their major infrastructure developments based on factors like future jobs, households and more, and to do side-by-side comparisons with different models.



A mapping scenario where different layers are overlapped in order to plan future transportation modalities.

#3 Reimagine

It is no secret that technology is massively influencing our infrastructure. Sensors, artificial intelligence (AI), drones, driverless cars, 3D, machine learning and more affect everything we build and plan for. The smart cities and communities of the future are closer than ever before.

So is your community imagining how it will look in 50 or even 100 years with these technology influences? Community leaders need to ask: Should we merely repair this road, or should we prepare for the future by setting up road sensors, becoming drone-ready or adapting streets to accommodate driverless cars?

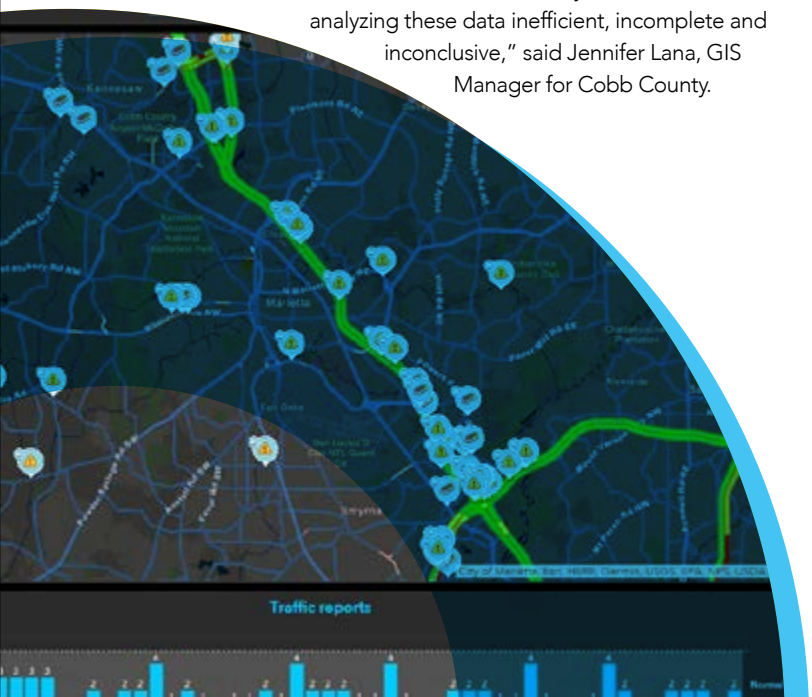
If industry analysts looking at the development of smart communities are correct, everything will be "sensorized" to collect data on road conditions, air quality, traffic flows, mobile devices and constituent feedback. Infrastructure itself will actively collect, store, monitor and use data. These factors need to be considered when building and designing new infrastructure. Is your jurisdiction prepared to consume these types of data feeds to make informed decisions?

Real-time GIS allows you to connect with sensor and streaming data, visualize it and analyze what to do next, allowing you to reimagine your infrastructure for the future. Reimagining means government must be forward-thinking, and building communities that are ready to support the technology of tomorrow. Departments can plan for the future by supporting real-time decision-making, leveraging the internet of things and thriving in a sensor-driven world.

Reimagine in Action: Cobb County, GA

The challenge: Cobb County, Georgia, is a county in flux. Since 2010, the county has grown by more than 70,000 residents; new tech companies are coming to town; and the city's staff is trying to figure out how to take applications like the internet of things and big data to completely reimagine what they're able to do with infrastructure and transportation for their residents going forward.

"The challenge faced is having a growing amount of data collected daily from mobile devices, WAZE, staff and citizen's data reside in their different systems, which makes analyzing these data inefficient, incomplete and inconclusive," said Jennifer Lana, GIS Manager for Cobb County.



The solution: "It is believed that leveraging the county's current GIS big data infrastructure, with these data from disparate systems to form a single 'smart community' platform will provide the opportunity to conduct data analysis using modern, cutting-edge methods and therefore realize new insights into how our intelligent transportation system (ITS) and county resources are used," Lana said.

In partnership with Georgia DOT, the county has created an ITS to improve the operation of its transportation network. The combination of GIS and ITS allows the Cobb County Department of Transportation to have access to a wide range of transportation-related data: AVL, Waze, Crash, travel speed, transit plus a wealth of data collected through the various Signal Systems.

Cobb County can use these data and initiatives for everything from the exciting 3D digital twin model of the county, and expand it with interactive community planning for new developments and line-of-sight analysis to adaptive traffic signal control – automatically adjusting traffic signal timing in real time based on actual traffic conditions detected at traffic signals to reduce traffic delays, Lana said.

Cobb County, Georgia's GIS-driven traffic dashboard.

Launching a Smart Infrastructure Strategy

Responding to the infrastructure crisis requires a different approach. Follow this framework to transform the way your organization rebuilds, rethinks and reimagines its infrastructure.

Organize Your Data

Governments have traditionally built datasets and information that allow quick access to the current state of your infrastructure. But gaps in data can be supplemented through open data sources and premium datasets such as demographic, lifestyle and socioeconomic variables. Incorporating all the variables that impact aging infrastructure leads to a better understanding of how your community needs to adapt.

Adopt a Data-Driven Approach

Forward-thinking organizations prioritize strategies and policies based on insights and analytics. Location analytics unveils new patterns that help you understand stresses on current infrastructure, including traffic patterns, public transportation access, telecommunications coverage and load capacities on water and sewer networks. Present and prioritize your information on dashboards to inform public officials and citizens so they are clear on the results of your analysis.

Become IoT Ready

Much like our homes, cars and devices, government is becoming more connected. It draws intelligence from citizens, vehicles, smart assets, GPS-enabled cameras and IoT-enabled infrastructures. With so much data coming from these sensors, how do you make sense of it all?

GIS allows you to consume, filter, monitor and analyze the data for faster, more accurate decision-making and improved outcomes. State and local governments are combining GIS and IoT to improve traffic flow, monitor stream gauges for flood management, aggregate social media feeds for citizen safety and public opinion, and so much more.

The Right Tools

Explore the tools introduced in this industry perspective to get started on the path toward strengthening and advancing your infrastructure needs.

ArcGIS Pro:

The latest advanced desktop tool that allows you to get started solving problems by visualizing, querying, creating, editing, analyzing and presenting geospatial data in both 2D and 3D environments. Create and manage your data, solve spatial problems and extend the reach of your GIS by sharing maps and apps with your entire organization.

GeoPlanner for ArcGIS:

A web-based planning tool that empowers you to rapidly design city-, regional- and landscape-scale scenarios in a collaborative, iterative environment. Design and test countless alternative scenarios and invite others to collaborate with you. Use built-in metrics and dashboards to immediately measure scenario impact. Access and incorporate global, authoritative data from ArcGIS for contextual analysis.

Insights for ArcGIS:

A web-based data analytics workbench for exploring spatial and non-spatial data, answering questions you didn't know to ask and quickly delivering powerful results. You can integrate and analyze spatial and tabular data for contextual analysis from your enterprise databases, ArcGIS data, geodatabases, Microsoft Excel spreadsheets and ArcGIS demographic data.

ArcGIS Enterprise:

A full-featured mapping and analytics platform that includes a powerful GIS server, plus dedicated web-based GIS infrastructure to organize and share your work. Access an enterprise GIS portal for organizing and sharing GIS assets, a data store for secure storage, and fast access to maps and data.

ArcGIS GeoEvent Server:

This tool connects to virtually any data feed so you can map, analyze and track objects in motion, such as vehicles, aircraft and vessels and stationary assets, such as weather and environmental-monitoring sensors. Gain real-time GIS monitoring of your most valuable assets for better decision-making the moment something happens.

Operations Dashboard for ArcGIS:

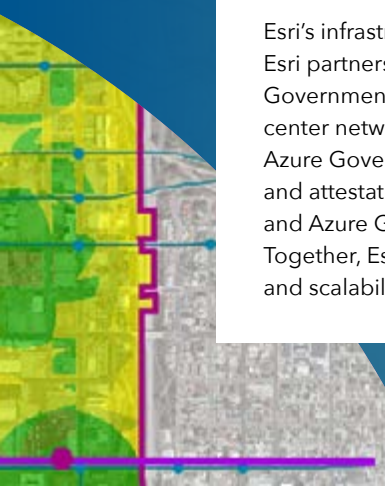
This tool provides location-aware data-mapping, infographics and analytics for a real-time operational view of people, services, assets and events. Monitor the activities and key performance indicators most vital to meeting your organization's objectives.

ArcGIS Community Analyst:

A web-based demographic tool that allows you to access spending, lifestyle and behavioral data that helps you better understand your community. Prioritize community projects, allocate resources for greatest impact and understand the types of people who are impacted by your decisions.

The Right Cloud Platform

Esri's infrastructure solutions can run on-premises, in the cloud or as an Esri Managed Cloud Service. Esri partners with Microsoft to enable government agencies to deploy GIS services on Microsoft Azure Government. Azure Government is the only government exclusive cloud with a dedicated physical data center network nationwide, designed for use by U.S. federal, state and local agencies and their partners. Azure Government provides the public sector with a trusted cloud technology with the most certifications and attestations of any cloud provider, and meets critical government compliance requirements. With ArcGIS and Azure Government, users can rethink infrastructure planning and operations to deliver better services. Together, Esri ArcGIS and Microsoft Azure Government provide the distributed processing power, security and scalability to monitor, analyze and share GIS information across your organization.



Conclusion

The nation's infrastructure is at a critical crossroads. Roads, sewers, bridges and transportation networks are in major need of upgrades and, simply put, the sustainability of our infrastructure is in question. Governments need to bring data together so it can be analyzed, understood and used to drive action, and community leaders need to leverage data across departments and groups.

GIS technology can be an integral component of governments' infrastructure strategy. Using GIS as a collaborative framework, communities can make more strategic decisions and monitor the performance of investments in infrastructure.

Responding to today's infrastructure crisis requires a different approach. By using geodesign and geographic information systems to transform the way governments analyze infrastructure challenges, communities will find cost-effective and data-driven solutions, and rebuild, rethink and reimagine infrastructure that can support both the communities of today and of the future.

When Esri was founded in 1969, we realized even then that geographic information system (GIS) technology could make a difference in society. Working with others who shared this passion, we were encouraged by the vast possibilities of GIS.

Today our confidence in GIS is built on the belief that geography matters - it connects our many cultures and societies and influences our way of life. GIS leverage geographic insight to ensure better communication and collaboration.

Explore our website to discover how our customers have obtained the geographic advantage by using Esri software to address social, economic, business, and environmental concerns at local, regional, national, and global scales. We hope you will be inspired to join the Esri community in using GIS to create a better world.

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Microsoft (Nasdaq "MSFT" @microsoft) is the leading platform and productivity company for the mobile-first, cloud-first world, and its mission is to empower every person and every organization on the planet to achieve more.

For more information visit **azure.com/gov**

GovLoop's mission is to inspire public sector professionals by serving as the knowledge network for government. GovLoop connects more than 270,000 members, fostering cross-government collaboration, solving common problems and advancing government careers. GovLoop is headquartered in Washington, D.C., with a team of dedicated professionals who share a commitment to the public sector.

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