GEOFUTURES

The Future of Geospatial is STLMade

A Strategic Roadmap for Advancing the Geospatial and Location Technology Cluster in the St. Louis Region

TECONOMY PARTNERS LLC

GEOFUTURES | FULL REPORT | JUNE 2020

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Table of Contents

Executive Summary i

Introduction to The STL GeoFutures Initiative 1
- St. Louis Has Done it Before – The Precedent of the St. Louis Plant and Life Science Roadmap 2
- Origins of the STL GeoFutures Initiative 3
- The Strategic Planning Effort of the STL GeoFutures Initiative 5

The Starting Point: The St. Louis Region's Longstanding Connections to Geospatial Development ... 9
- The Unfinished Agenda: The Underrepresentation of St. Louis' African-American Community in Geospatial and Broader Tech Sectors and the Need to Advance Equity, Diversity, and Inclusion 11

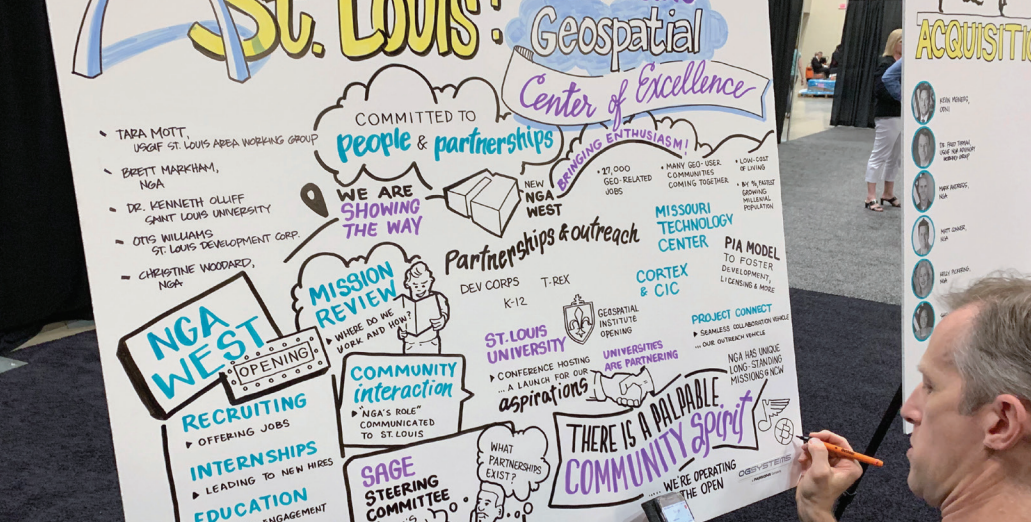
The Forward-Looking Opportunities for STL GeoFutures 17
- Setting the Context: Geospatial Technologies and Applications Offer a Pathway to Transformative Innovation Growth 17
- Positioning St. Louis for Future Transformative Growth through Geospatial Development 21
- A Path Forward for St. Louis – Focus on Being a Global Leader in Advanced Technology Applications of Locational Data 31

The Competitive Position of St. Louis in the Geospatial Sector 43
- Benchmarking Critical Ecosystem Elements for a Thriving Tech-Based Industry Cluster 44

Setting a Strategic Roadmap for STL GeoFutures 51
- Strategic Vision and Objectives 51
- Strategic Priority A: Scaling Up Talent and Workforce Development to Meet Geospatial Industry Demand 54
- Strategic Priority B: Raising Innovation Capacity for Advanced Geospatial Technology Applications for Leading Industry and Community Development Drivers 62
- Strategic Priority C: Accelerating Entrepreneurship and Availability of Risk Capital 68
- Strategic Priority D: Support the Advancement of Community-led Neighborhood Development in North St. Louis 73
- Strategic Priority E: Brand and Position St. Louis as a Global Thought Leader in Geospatial-related Development 78
- The Design for Implementation 80

Looking Ahead 89

Acknowledgements and Recognition of Regional Stakeholder Input 93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GEOFUTURES

EXECUTIVE SUMMARY

Executive Summary

St. Louis is mobilizing around a significant innovation cluster in geospatial technologies and applications, where it can stand out and build competitive advantage at a scale that can impact its broad regional economy and be a driver of transformative, inclusive and equitable growth.

St. Louis has had a prominent place in the history and ongoing activities of geospatial development. Dating back to the Lewis and Clark Expedition, St. Louis has been a gateway for exploration with a legacy of mapping the world around us. With the advent of aerial photography and the demands in WWII for accurate base maps and navigational aids, the science of photographic interpretation and map-making took a major leap forward, and once again St. Louis was at the forefront. Beginning in 1943, with the establishment of the Army's Air Forces Aeronautical Chart Plant, St. Louis has become a leading hub for military map-making and locational analysis, now represented by the National Geospatial-Intelligence Agency (NGA) West headquarters.

Today, this longstanding and strong connection to the NGA has anchored the development of a substantial base of economic activity for St. Louis and a broader eco-system for talent development, research and innovation and entrepreneurial development, that can root and sustain long-term economic competitiveness and growth in geospatial development (see: Snapshot of Baseline Geospatial Activities in St. Louis). With its approximately 3,700 high-paying jobs, NGA is one of the St. Louis region's largest employers. Remarkably, up until 2017, this base of activity in geospatial-related development was largely unrecognized in St. Louis given the mission of NGA as a critical agency for U.S. intelligence.

But it took a catalyzing event to mobilize the St. Louis community to recognize its broader potential in geo-spatial technologies and applications. This event was the competition and decision in 2016 to locate the new $1.7 billion state-of-the-art "Next" NGA West, commonly referred to as "N2W," on a 97-acre site just north of Downtown St. Louis. The headquarters is the largest federal headquarters project in the City of St. Louis.

A Word About the National Geospatial-Intelligence Agency (NGA)

A unique combination of intelligence agency and combat support agency, NGA serves as the world leader in providing timely, relevant, accurate and actionable geospatial-intelligence. By evaluating imagery, maps, charts, multiple layers of foundation data (such as terrain, elevation and gravity) and more, NGA's intelligence specialists help users visualize what is happening at a particular place and time, going beyond describing 'what, where and when' to revealing 'how and why.' NGA's work enables decision-making for policymakers, warfighters, intelligence professionals and first responders.

Source: NGA, approved for public release, 17-466

Now the St. Louis region is coming together as one community to advance geospatial-related development as an innovation cluster for the first time since the renowned Plant and Life Science Roadmap. Under the leadership of Dr. Bill Danforth, John McDonnell and others in the late 1990s, St. Louis pursued a focused cluster strategy that has made the region the global center of excellence for agricultural technology and broader life sciences, and has led to key organizational efforts, such as BioSTL, BioGenerator, Danforth Plant Science Center and Cortex, that have stood the test of time and sustained an increasingly vibrant and growing life sciences cluster. In 2018, The Brookings Institution featured the St. Louis plant and life sciences cluster initiative as one of five best practice examples on the basis of its sustained success in fostering the cluster's growth and development.

A Snapshot of Baseline Geospatial Activities Found in St. Louis

A significant economic base of activity and jobs in the region:

- NGA alone employs directly 3,700 workers in the St. Louis region. With salaries averaging $75,000, this stands well above the region's average annual salaries of $54,000.*
- Through NGA's base of defense contractors and other private industries involved in geospatial technologies and applications, such as surveying, logistics, remote sensing and imaging instruments and locational data analysis, there are more than 6,600 jobs across nearly 350 companies in St. Louis. Combined with the nearly $20 million in university R&D grants in geospatial-related research, this generates a total economic impact reaching 27,000 jobs and nearly $5 billion in economic activity for the St. Louis region.

A driver of broader IT and other STEM skills:

- While the modern geospatial workforce continues to include "traditional" occupations and job titles such as cartographer, surveyor, and geographer, the talent base and skill sets are increasingly oriented within "related" IT and data sciences roles such as systems and software engineers, data analysts and scientists, business analysts and design engineers. Some of the top skill requirements in regional geospatial job postings include information systems, programming in Python, data manipulation, and algorithm development, in addition to knowledge of core geosciences—a clear demand for "hybrid" skill sets.
- Taken all together, this geospatial-related occupational workforce in the St. Louis region is large and has grown rapidly since 2015 (up 11 percent) and outpacing national growth to reach nearly 53,000 employed in key geospatial occupations.
- St. Louis' colleges and universities are growing their educational programming and graduate levels in geospatial-related degree fields, increasing graduate levels by nearly 23 percent from 2015-17, a rate more than double that seen nationally.

An emerging area of research and innovation for St. Louis:

- The region's universities conduct nearly $39 million annually in research involving geospatial-related fields, including nearly $20 million in grants with identified geospatial-specific research, and have generated more than 1,300 geospatial research publications in recent years.
- A wide range of university research centers and initiatives involving geospatial technologies and applications are active.
- There have been 14 VC investment deals involving St. Louis geospatial companies since 2015. Local entrepreneur-support organization Arch Grants, which provides $50,000 equity-free grants and pro bono support services to entrepreneurs who locate early-stage businesses in St. Louis, announced in 2019 that it was awarding five additional grants each year specifically to geospatial startups.
- The St. Louis economic development and geospatial communities are mobilizing to create a platform to activate innovation and entrepreneurship in geospatial technologies and applications.

**Note: In the City of St. Louis, NGA presently employs 3,150 workers with an average salary of $101,000.*

Defining Geospatial Technologies and Applications in Driving STL GeoFutures in St. Louis

"Geospatial" refers to the collection and processing of data that is associated with location and spatial analysis for better situational awareness and decision-making. For decades, the use of geospatial technologies and applications had limited commercial uses.

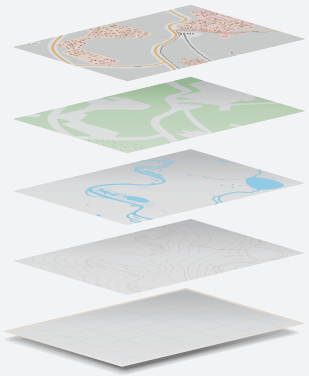
But today, geospatial technologies and applications have been unleashed and are becoming a common fabric in our daily lives. Applications using locational data are now ubiquitous on smart phones, helping people make decisions from how to drive to where to eat, all in real time.

For industry, the 'where' dimension is redefining how businesses operate, with locational data now being a key component in how companies market their products and services, support customers, manage supply chains and ultimately grow their businesses.

Today, the geospatial marketplace involves a rich assortment of technology-based solutions, such as global positioning systems, earth observation, 3D scanning and spatial analytics. Altogether the geospatial market is large and growing fast. The research firm MarketsandMarkets estimates the geospatial market at $239.1 billion in 2019 and growing to $502.6 billion by 2024, a 13.2 percent compound annual growth rate over this five-year period.[1]

Looking to the future, geospatial development is shaping up to be a key enabler of the Fourth Industrial Revolution – in which the merging of physical and digital worlds fundamentally changes the way we live, work and relate to one another. The need for real-time locational data for decision-making and situational awareness will accelerate under the Fourth Industrial Revolution. This will involve cutting-edge technologies such as remote imaging and sensing, smart devices in cyber-physical systems, autonomous systems and Big Data predictive analytics powered by artificial intelligence and machine learning to drive innovations in our daily lives. So, geospatial development is not just a narrow set of technologies and applications, but a fundamental and enabling part of the larger digital transformation taking place in the decades ahead. Given the advanced technology nature of the growing uses of geospatial-related applications, locational data and spatial analysis, we have termed this opportunity for St. Louis as the "STL GeoFutures Initiative."

The term "geospatial" arises from the ability to assemble a range of location-based data into a layered set of maps and other products and applications that integrate boundaries, infrastructure, elevation, geodetic (magnetic and gravimetric), human geography and images



Given the advanced technology nature of the growing uses of geospatial-related applications, locational data and spatial analysis, we have termed this opportunity for St. Louis as the STL GeoFutures Initiative.

1 *MarketsandMarkets, Geospatial Solutions Market by Technology, Solution, End-User, Application and Region – Global Forecast to 2024, see https://www.marketsandmarkets.com/Market-Reports/geospatial-solution-market-206125202.html?gclid=EAIaIQobChMI9KK9h-rM5wIVHYVaBR16ug-MoEAAYASAAEgLhqfD_BwE*

The STL GeoFutures Initiative Efforts Focus on Advancing a Strategic Roadmap

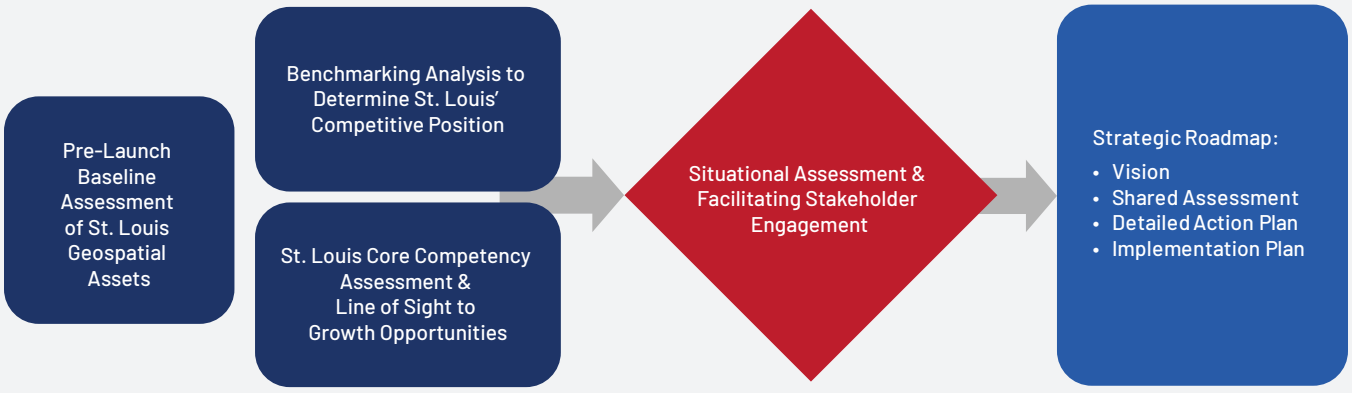
The objective of the STL GeoFutures Initiative is to enable the St. Louis region to realize its full potential as a global center of excellence in geospatial-related development. This requires a Strategic Roadmap that brings a community together around a shared vision of the future and what it will take to get there – including an overall situational assessment for positioning the region for success in geospatial development.

A broad stakeholder Advisory Committee of twenty-nine leaders representing industry, education, community and economic development has come together as one team for St. Louis to guide the development of the Strategic Roadmap. This effort involved five meetings of the STL GeoFutures Initiative Advisory Committee, the input of over 120 companies and organizations involved in geospatial-development and broader economic and community development of the region, as well as the input from six focus group meetings involving 80 participants.

The culmination of this extensive and deliberate process of analysis, outreach and discussions is a Strategic Roadmap to provide the framework for the St. Louis region to realize its potential in geospatial development. The key elements of this Roadmap set out below in Figure ES-1 include:

- A shared vision of success to serve as the mission statement for the STL GeoFutures Initiative with near-term and longer-term objectives on how to reach this vision.
- A game plan of specific strategic priorities and actions that is comprehensive and tailored to the situational assessment found in the St. Louis region of opportunities to be realized and areas of improvement that need to be addressed, in concert with ongoing activities and existing resources as well as informed by best practices in innovation cluster development.
- An implementation plan that measures up in its governance, organizational approach and activities to build upon the STL GeoFutures Initiative process and offer a catalytic and sustainable means to steer, invest, convene, and engage for future success.

FIGURE ES-1: OVERVIEW OF STEPS IN STRATEGIC PLANNING EFFORT FOR STL GEOFUTURES



Strategic Vision and Objectives of the STL GeoFutures Initiative: Building Upon an Analysis of the St. Louis Region's Competitive Position and Line-of-Sight to Growth Opportunities

The vision that emerged for the STL GeoFutures Initiative is **BOLD** in its ambition and focus. Underpinning this vision are two key observations that the stakeholders strongly embraced:

1. The STL GeoFutures Initiative is ideally situated to be a driver for equitable and inclusive regional growth. The Initiative offers a means to engage disinvested people and places, particularly Black residents, in employment, ownership and broader community wealth generation. It can also improve the fundamental preconditions shaping the ability of people and places to participate in economic growth using the technologies and tools of geospatial development to address population health, transportation access, and crime and safety, among other socioeconomic challenges, through inclusive, community-led Smart Cities initiatives.

   Today, despite the significant activities in geospatial development found in the St. Louis region, equitable and inclusive growth is not being realized. St. Louis' geospatial workforce, its university degree programs, and its entrepreneurial community far from reflect the region's diverse population of residents:

   - In workforce, African-Americans are just 9 percent of the geospatial-related workforce, roughly half the level of total employment in the region.
   - In talent generation, just 6 percent of the graduates in geospatial-related degree programs are African-American.
   - In entrepreneurship, African-Americans comprise only 3 percent of self-employed individuals in geospatial industries.

These findings have been reinforced consistently in discussions with community leaders and geospatial industry stakeholders during this Roadmap effort.

Vision for STL GeoFutures Initiative

Build upon the St. Louis region's substantial assets and deep connections to geospatial development for national security to further transformative, equitable and inclusive growth as a global center of excellence for advanced technology applications of locational data in leading industry sectors and community services.

2. The STL GeoFutures Initiative offers a distinctive competitive advantage for St. Louis to fully participate and take a leadership role in the Fourth Industrial Revolution. The merging of digital and physical worlds, by leveraging the cutting-edge technologies used in location-based data and applications, such as remote imaging and sensing, smart devices in cyber-physical systems, autonomous systems and Big Data predictive analytics powered by artificial intelligence and machine learning.

By building upon St. Louis' current assets and competitive advantages, this vision is also REALISTIC. Like any cluster initiative, it is important for the STL GeoFutures Initiative to have a line-of-sight to growth opportunities where the St. Louis region has a comparative advantage.

Several key findings emerge that suggest how St. Louis is best-positioned to compete in geospatial development and advance growth opportunities. These findings are based on comprehensive assessments of the national innovation landscape of geospatial innovation and overall technology competencies found in St. Louis, plus a competitive benchmarking analysis with five other leading geospatial regions. These analyses reveal:

- **St. Louis stands out in the size, concentration, and growth of its geospatial and broader tech talent base compared with the nation and other regions.** The region employs nearly 53,000 in geospatial-related occupations, with the bulk of these workers in key

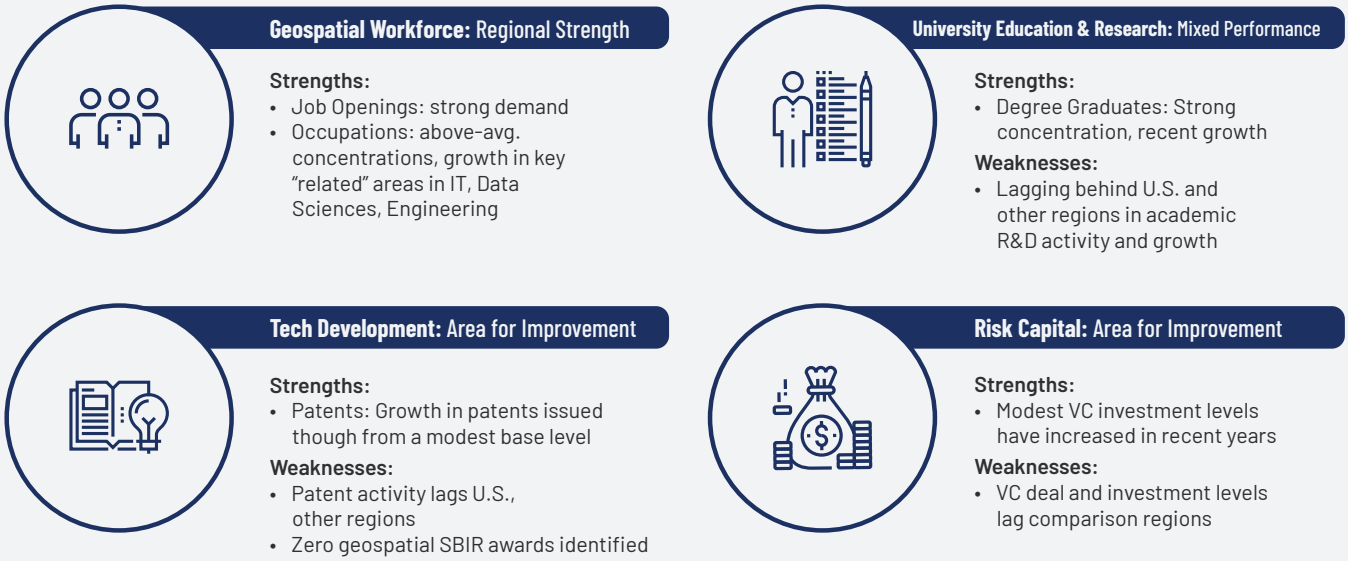
areas in IT, data sciences, and electrical engineering. In these critical "related" job and skill areas, the region is 15 percent more concentrated relative to the national average and has grown at a double-digit pace, outpacing national growth since 2015.

- **In specific geospatial efforts relating to innovation, such academic research, patent innovations and venture-backed startups, the St. Louis area has modest levels of activity that lags leading benchmark regions**. So, innovation in specific geospatial technologies today is not a competitive advantage for St. Louis.

- **Still the St. Louis region does possess identified strengths in advanced computing and data sciences across all of its patent, publications and venture capital activities that could be leveraged towards advanced geospatial technology applications.** Specifically, there is a distinct network of IT and analytics patent innovations in St. Louis that is focused on authentication and validation of financial transactions and is closely linked with digital health, imaging analysis and location tracking systems. Plus, publications activity reveals a critical mass of activities in enabling technologies of data sciences, imaging, remote sensing, computer sciences and associated hardware that could be leveraged towards geospatial applications. Similarly, the technology verticals associated with venture capital activity in the St. Louis region also emphasize advanced computing and data sciences technologies.

This suggests that the St. Louis region is best positioned to focus on the ability of its talent base to adopt and integrate the latest advances in computing and data sciences into geospatial applications that enhance the value of locational data for decision-making and situational awareness to ensure our nation's security, grow businesses and address community needs. It is well understood by market researchers of geospatial development that one path to realizing the future value of geospatial technologies and applications is closely connected to specific industries and their applications of advanced technology.

FIGURE ES-2: SUMMARY COMPETITIVE POSITION OF ST. LOUIS IN KEY ECOSYSTEM ELEMENTS BASED ON BENCHMARKING



Source: TEConomy Partners' analysis.
Note: Five benchmark regions that St. Louis was compared with include: Greater Denver, Greater Los Angeles, Philadelphia metro, Silicon Valley and Washington, DC metro.

Four specific leading industry sectors in St. Louis were identified as being closely aligned with the use of locational data and geospatial technologies for their competitive advantage, including:

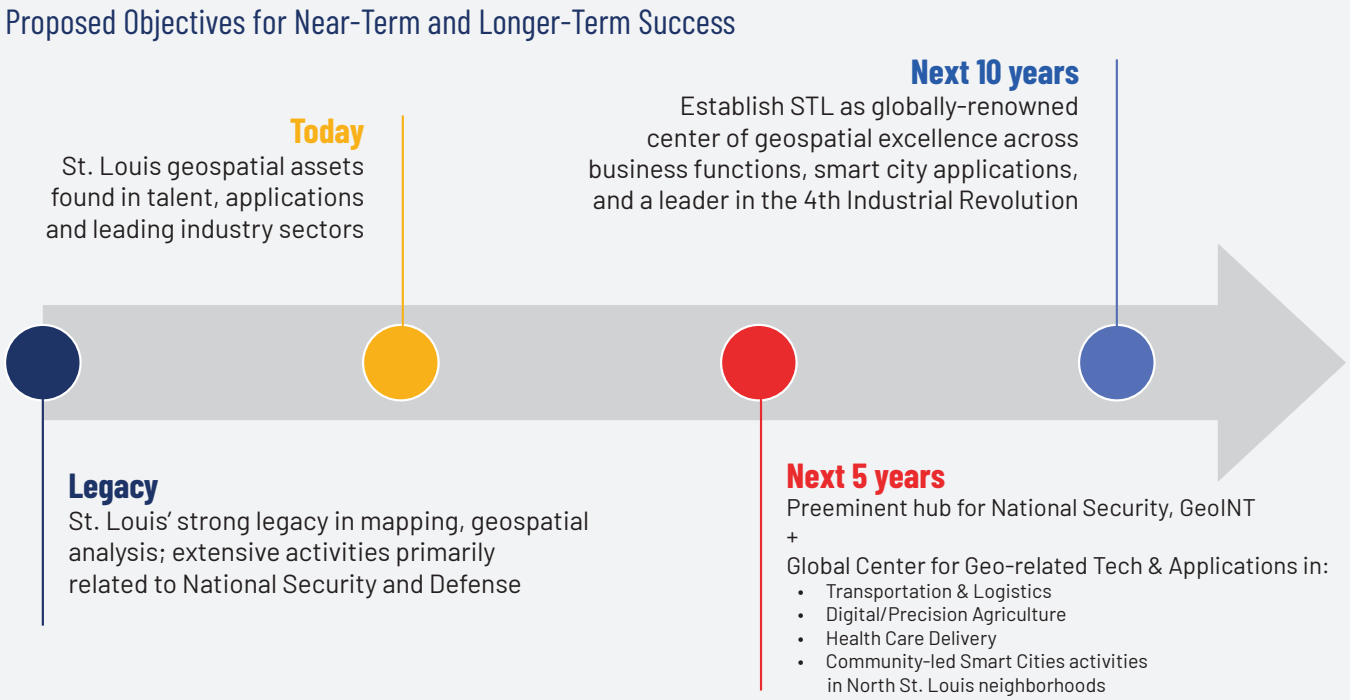
- National Security
- Digital/Precision Agriculture
- Transportation & Logistics
- Health Care Delivery

FIGURE ES-3: SUMMARY OF LIKELY GROWTH OPPORTUNITIES ALIGNING LEADING INDUSTRY SECTORS IN ST. LOUIS WITH DEMAND FOR LOCATIONAL TECH APPLICATIONS

The specific near-term objective of the STL GeoFutures Initiative is to focus St. Louis as the global thought leader in geospatial applications, building on its leading industries and community priorities. Over the next five years, St. Louis needs to consolidate its position and become the preeminent hub for national security applications of geospatial intelligence, while also building upon its base of industry strengths in areas such transportation and logistics, digital/precision agriculture and healthcare delivery to leverage its computing and data sciences technology strengths for advanced locational applications. This requires a broad engagement across industries and communities in St. Louis on the value of locational data and market-driven innovations involving location tech applications complemented by a focus on inclusive and equitable growth in talent pipelines and workforce development, and entrepreneurial business development.

In the longer term, through the nexus of industry-university-government-community engagement around locational tech applications, St. Louis will stand out as a global thought leader and have a strong standing across artificial intelligence/machine learning, cyber-physical systems/IoT, and autonomy, among other critical technologies. This will raise the region's overall capacities and assets to fully participate as a leading hub in the Fourth Industrial Revolution.

FIGURE ES-4: DEPICTION OF DEVELOPMENT ROADMAP FOR THE STL GEOFUTURES INITIATIVE INVOLVING NEAR-TERM AND LONGER-TERM OBJECTIVES



RECOMMENDED STRATEGIC PRIORITIES AND APPROACHES FOR INVESTMENT TO ENHANCE STL GEOFUTURES

This vision and objectives for the STL GeoFutures Initiative identified opportunities and strengths to build upon, as well as gaps to address in the capacities of the St. Louis region to compete for geospatial development as a global center for advanced technology applications for locational data.

The Strategic Roadmap calls for five strategic priorities to be addressed, involving three signature initiatives and several collaborative program activities, as depicted below.

Of particular importance are the three signature initiatives, which represent broad activities that are expected to be most impactful for advancing the St. Louis region, including:

- **STL GeoFutures Coalition:** Serve as the lead initiative and umbrella for all STL GeoFutures activities as a catalytic steering, investing, convening and leadership development organization to oversee the Roadmap implementation and ensure a sustained commitment to racial equity and inclusive growth across all Roadmap activities.

- **STL GeoFutures Talent Initiative:** Support and deepen ongoing K-16 and adult workforce geospatial-related technical education provider efforts, with a particular focus on under-represented communities, particularly Black communities.

- **STL GeoFutures Innovation Collaborative:** Address the opportunity and challenge to "establish STL as a leader in advanced technology applications of locational data" that can drive national security, commercial and community innovation, commercialization and entrepreneurship.

Table ES-1 sets out the details for each of the signature initiatives, including objectives,

FIGURE ES-5: OVERVIEW OF STRATEGIC PRIORITY AREAS, SIGNATURE INITIATIVES AND COLLABORATIVE PROGRAM ACTIVITIES FOR STL GEOFUTURES INITIATIVE ROADMAP

associated strategic priority, activities, governance and operations.

The collaborative program activities are more targeted to address specific opportunities and gaps that need to be advanced with the broader St. Louis community, including:

- **Establishing an entrepreneurial program for Black tech professionals, with an emphasis on locational tech applications.** The STL GeoFutures Initiative should focus on cultivating relationships with Black professional associations of IT and engineering professionals to provide entrepreneurial services to their members, as well as other under-represented tech professionals. These efforts should leverage the presence of existing entrepreneurial development activities, such as WEPOWER's Elevate/Elevar accelerator, BDPA, and future directions by the St. Louis Equity in Entrepreneurship Collective. Best practices suggest the importance of offering a formal programming approach that helps Black professionals consider the option of starting their own businesses, including training and coaching in customer discovery and business concept development.

- **Creating an affiliated matching fund for geospatial venture investments.** Discussions with stakeholders identified that St. Louis is still emerging in tech-based startups, but that the entrepreneurial ecosystem is maturing. Rather than a new direction, stakeholders suggested it would be better to provide a means to facilitate and enhance the ability of existing venture funding sources to syndicate with capital from outside the region in providing scale-up funding for geospatial-related startups. An efficient and sustainable approach will be to focus on qualifying St. Louis geospatial companies for matching investments that can be used to leverage funding from other sources of capital, including from outside of St. Louis. For emerging St. Louis geospatial startups, the critical time would be as they seek their Series A round of investments and, in essence, would offer an incentive to share the risk with formal venture capital funders. It also has the advantage of allowing the market to determine valuation and terms and have the STL GeoFutures Initiative simply act as a "silent" co-investor.

- **Supporting a community-led effort to form a neighborhood development entity in North St. Louis where the new NGA West headquarters is to be located.** In concert with the continued efforts of Project Connect and in alignment with the soon-to-be-released City's Equitable Growth Framework, STL GeoFutures Coalition should support community-led neighborhood development efforts in North St. Louis. The focus of this support should be to advance social innovations to drive improved quality of life through Smart City applications as well as broader community wealth building activities[2] to grow incomes and assets of neighborhood residents by enhancing their skills, access to quality jobs, entrepreneurship and home ownership.

2 *Bruce Katz, Ross Baird and Daniel Palmer in their white paper "Towards a New System of Community Wealth" issued on October 27, 2019 by Drexel University Nowak Metro Finance Lab with BluePrint Local and Accelerator for America define community wealth as "a broad-based effort to build equity for low-income residents of disadvantaged communities with the aims to: 1) Grow the individual incomes and assets of neighborhood residents by equipping them with marketable skills and enabling full or partial ownership of homes, commercial properties and businesses; 2) Grow the collective assets of neighborhood residents by endowing locally-run organizations with the ability to create, capture and deploy value for local priorities and purposes; 3) Improve the access to private capital that has high standards, fair terms, a long-term commitment to the neighborhood and reasonable expectations around returns and impact; and 4) Enhance inclusion by bringing fairness and transparency to neighborhood revitalization so that community voices are heard and respected and trust is restored, and local residents have the opportunity to participate in wealth that is created." See https://drexel.edu/nowak-lab/publications/reports/community-wealth/ for more details.*

TABLE ES-1: DETAILS OF THE DESIGN OF THE SIGNATURE INITIATIVES RECOMMENDED FOR THE STL GEOFUTURES ROADMAP

	STL GeoFutures Coalition	STL GeoFutures Talent Initiative	STL GeoFutures Innovation Collaborative
Associated Strategic Priority	Brand and position St. Louis as a global thought leader in geospatial-related development Lead Implementation for STL GeoFutures Roadmap	Scale up talent and workforce development to meet geospatial industry demand	Raise innovation capacity for advanced geospatial technology applications for leading industry and community development drivers Support for acceleration of entrepreneurship and availability of risk capital
Objective	Serve as a catalytic steering, investing, convening and leadership development organization to raise funding and oversee the Roadmap's implementation and ensure a sustained commitment to racial equity and inclusive growth across all Roadmap activities	Support and deepen ongoing K-16 and adult workforce geospatial-related technical education provider efforts targeted to under-represented communities	Address the opportunity and challenge to "establish STL as a leader in advanced technology applications of locational data" that can drive national security, commercial and community innovation, commercialization and entrepreneurship
Activities	Oversee and monitor the Roadmap's implementation, measures of success and future needs for advancing geospatial-related development Convening leadership from across industry, universities, government, and disinvested communities, and pursuing collaborations for public-private and multi-sector partnerships Serving as an investor and "wholesale" contracting organization that seeks to scale-up and enhance ongoing efforts and engage organizations to undertake additional needed program activities Position St. Louis as a global thought leader in geospatial development through: branding and marketing activities, coordinated with broader regional economic development efforts; networking and leadership development; and conference development and sponsorship Establish a capacity for career connections that aggregates industry needs and requirements, offers a job posting board and facilitates matching interns and recent graduates with employers	Strategic investor and coordinator of geospatial-related education and training efforts Play a key liaison role, consistently monitoring industry supply-demand conditions for talent and translating industry needs to academia as an interface with the regional SLAWG group, as well as with NGA and with USGIF K-12 and Workforce Development – • Grant-making function dedicated toward supporting and deepening ongoing geospatial STEAM programs, as well as overseeing efforts to pilot and advance new ones. • Technical assistance and funding support to targeted school districts Post-Secondary – • Support curriculum development • Scholarships and internships for disinvested students Adult Learners – • Target veterans, people with some college and the underemployed through integrated short-term training and placement services	Engage industry, university and community partners to focus on targeted industry and community drivers for advancing geo-related applications Identify market-driven applications development needs through customer engagement, workshops, conferences, and white paper development Offer competitive commercialization grants for early-stage geospatial-related tech startup ventures that includes funding for proof-of-concept projects and for free or discounted space, with follow-on funding available for successful startups through a matching venture capital investment fund Support matching grants for applied R&D projects with industry to partner with universities and emerging IT startups Provide university research enhancement funding in emerging technology areas, such as quantum computing, cyber-physical systems and autonomous systems Support Site Minders at universities and research institutions to tap expertise First customer program Demonstration and testing center

	STL GeoFutures Coalition	STL GeoFutures Talent Initiative	STL GeoFutures Innovation Collaborative
Governance	Seek broad representation from leaders of geospatial-related industry, universities, government, economic and workforce development and civic organizations and community-based racial equity and inclusion organizations	The STL GeoFutures Coalition would oversee the STL GeoFutures Talent Initiative including approving funding	Independent non-profit organization; industry-led board, with representation of university VPRs, federal labs and research organizations
Operations	Involve staff with capabilities in strategic planning, communications and marketing, and management of contracts with a network of providers. Based on other cluster hub organizations likely to require 10-12 staff positions	The STL GeoFutures Coalition would budget, staff and oversee the grant-making function	Involve entrepreneurs-in-residence to lead effort; require technical staff to oversee demo/testing center

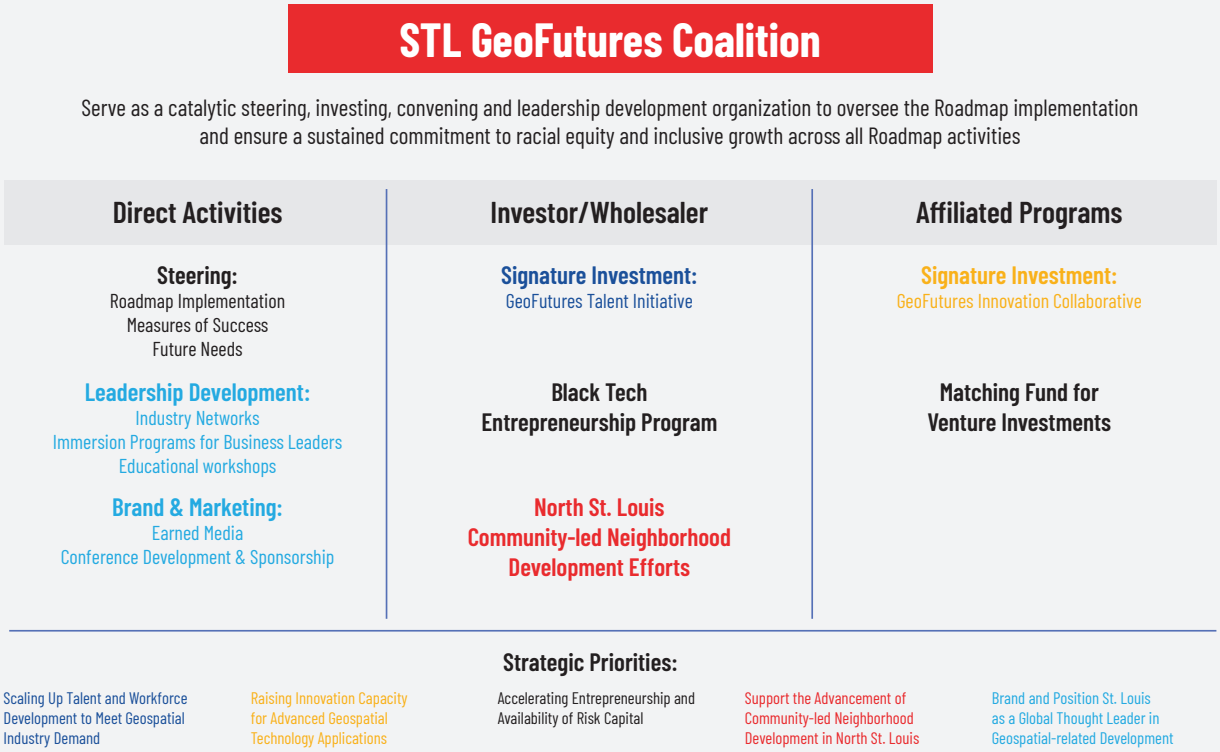
The final element of the Strategic Roadmap is an implementation approach that is able to institutionalize broad community stakeholder engagement and collaboration building upon the mobilization achieved in the STL GeoFutures Initiative. In particular, the action plan set out in the Roadmap is beyond the scope of any individual institution, so collaboration is key to success. Yet, it is well understood that collaboration among organizations, each with its own mission and activities, is not a natural phenomenon, but one that needs to be intentional and can only be maintained through careful attention to broad-based facilitation and engagement.

At the same time, the shared vision and action plan for the STL GeoFutures Initiative in its implementation must embrace and not displace the substantial efforts already underway to support geospatial development in St. Louis by individual institutions and organizations. Unlike the situation faced 20 years ago when the Plant and Life Sciences Roadmap was conceived, there is a far more advanced set of development resources in place which the STL GeoFutures Initiative can tap and, most importantly, are already seeking to seize upon the opportunity for geospatial development.

To lead the implementation, it is recommended that the STL GeoFutures Coalition serve as the "cluster hub" for geospatial development in St. Louis. It would largely function as a steering and investing organization that engages and convenes the full community and seeks to enhance and leverage the capacities of existing and emerging resources and organizations to accomplish the vision of the Strategic Roadmap with strong emphasis on accountability in achieving results that are inclusive and equitable. Still, the STL GeoFutures Coalition would play a direct role in a number of critical functions beyond steering and investing. This includes being the lead on the strategic priority to brand and position St. Louis as a global thought leader in geospatial development, as well as having a role in supporting career connections across industry, educational institutions, workforce training providers, students and job seekers.

Figure ES-6 sets out the different roles that the STL GeoFutures Coalition would play across strategic priorities and actions. Beyond the direct activities of the Coalition, it would be an investor that solicits and contracts for services from education and workforce providers for the STL GeoFutures Talent Initiative, industry associations and entrepreneurial development groups for the Entrepreneurship Program for Black Tech Professionals and North St. Louis neighborhood organizations for community wealth creation and Smart City applications to benefit local residents. The STL GeoFutures Coalition will also help establish and fund the STL GeoFutures Innovation Collaborative as an industry-led organization as well as seek private sector management for the Matching Fund for Venture Investments in geospatial-related companies, so these are considered more affiliated though separately operated activities of the Coalition.

FIGURE ES-6: OVERVIEW OF THE IMPLEMENTATION OF STRATEGIC PRIORITIES AND ACTIONS UNDER THE STL GEOFUTURES COALITION



One of the most important roles of the STL GeoFutures Coalition, as indicated above, will be to oversee and monitor the Strategic Roadmap implementation, which includes identifying and tracking performance across measures of success.

For the STL GeoFutures Initiative's Strategic Roadmap, it will be of particular importance to track who actually benefits from the signature initiatives and other actions undertaken. This needs to be considered from both a focus on outputs or who is participating in receiving services from program activities, as well as on outcomes or what are the results across population groups. Table ES-2 sets out specific output and outcome measures across the five strategic priorities to help think through overall performance measurement for the STL GeoFutures Roadmap.

TABLE ES-2: RECOMMENDED PERFORMANCE MEASURES FOR TRACKING SUCCESS OF THE STL GEOFUTURES ROADMAP ACROSS STRATEGIC PRIORITIES

Strategic Priority	Output Measures	Outcome Measures
Scale Up Talent and Workforce Development to Meet Geospatial Industry Demand	• Number of participants in educational and training programs supported tracked by race, ethnicity, gender and place of residence	• Certifications and Degrees Awarded by race, ethnicity, gender and place of residence • Job placements of participants by race, ethnicity, gender and place of residence
Raise Innovation Capacity for Advanced Geospatial Technology Applications for Leading Industry and Community Development Drivers	• Faculty recruited by race, ethnicity, gender and place of residence • Number of companies participating in applied research/innovation project efforts • Recipients of proof-of-concept funding by race, ethnicity, gender and place of residence • Number of participants in activities, such as hack-a-thons, student design projects, community Smart City pilots, etc. by race, ethnicity, gender and place of residence	• Research funding generated by faculty recruited by race, ethnicity and gender • Leveraged funding from federal and private sources, such as SBIR/STTR awards and follow-on angel, seed and formal venture capital, generated from proof-of-concept projects tracking entrepreneurs by race, ethnicity, gender and place of residence • New products advanced, including patents awarded, sales generated • New geospatial-related companies formed tracking entrepreneurs by race, ethnicity, gender and place of residence
Accelerate Entrepreneurship and Availability of Risk Capital	• Participants in entrepreneurship programs supported by race, ethnicity, gender and place of residence • Companies invested in tracking entrepreneurs by race, ethnicity, gender and place of residence	• New geospatial-related companies formed tracking entrepreneurs by race, ethnicity, gender and place of residence • Leveraged funding generated in geospatial-related companies tracking entrepreneurs by race, ethnicity, gender and place of residence
Community-led Neighborhood Development in North St. Louis	• Number of North St. Louis residents participating in community wealth building projects (job training, entrepreneurship and home ownership) by race, ethnicity, gender • Number of North St. Louis residents participating in Smart City applications	• New businesses launched through community wealth building tracking jobs generated and sales generated • New home ownership by North St. Louis residents • North St. Louis residents in job training hired for jobs in field of training
Brand and Position St. Louis as a Global Thought Leader in Geospatial-related Development	• Number of conferences, workshops, industry network events • Participants in leadership development programs and industry networking by race, ethnicity, gender and place of residence	• National stories on STL GeoFutures • Out of state participants in conferences and workshops held in St. Louis

Beyond the performance measures of specific program activities across each strategic priority, it will be important to track on an annual basis the overall position of St. Louis in geospatial development. This would involve replicating the benchmarking analysis as well as tracking racial and ethnic participation in all geospatial-related activities in degrees, jobs and self-employment on at least a biennial if not annual basis.

Across the breadth of the innovation ecosystem, the specific benchmark measures to be tracked include:

Geospatial Workforce
- Job openings
- Occupational employment by race, ethnicity and gender

Geospatial-related University Education & Research
- Degree graduates
- R&D expenditures

Geospatial Tech Development
- Patents
- SBIR/STTR awards

Geospatial Entrepreneurial Development and Risk Capital
- Self-employment in geospatial-related industries by race, ethnicity and gender
- Number of new early-stage venture capital-backed startups (pre-seed, angel investor and seed) by race, ethnicity and gender of founders
- Venture Capital investments by race, ethnicity and gender of founders
- Follow-on investments after early-stage funding by race, ethnicity and gender of founders

This comprehensive approach to performance measurement will enable the STL GeoFutures Coalition to effectively demonstrate how geospatial development is advancing and the effectiveness of its program activities aligned with the focus on inclusive and equitable growth. It will also allow the STL GeoFutures Coalition to become a leading source of intelligence on geospatial development around the nation.

Looking Ahead

St. Louis has had a long and rich history with geospatial development, but never an intentional one focused on making it a regional innovation and growth driver. This Strategic Roadmap set out by the STL GeoFutures Initiative represents the first time St. Louis has put in place a framework to link, align and enhance the capabilities of the St. Louis region's innovation ecosystem to fully realize the transformative, inclusive and equitable growth driver that geospatial development represents for the region. But it will take patience to put all of the pieces in place to initiate and advance the recommended signature initiatives and focused action steps to bring this Strategic Roadmap fully to life.

In the weeks ahead, the imperative is to institutionalize the strong level of community engagement and collaboration into a formal STL GeoFutures Coalition to serve as the cluster hub for geospatial development. Through the Coalition, it is expected that St. Louis can mobilize and sustain the public and private support and engagement to use this Strategic Roadmap as the framework for implementation.

This Strategic Roadmap represents a critical starting point. As investments are made and the recommended signature initiatives and focus program activities implemented, this Strategic Roadmap will need to be refined as an operating plan for progress by the Coalition. It is an effort worthy of the journey ahead.

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GEOFUTURES

INTRODUCTION

TO THE STL GEOFUTURES INITIATIVE

Introduction to The STL GeoFutures Initiative

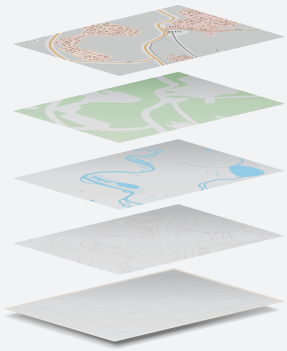
With its strong regional innovation capacity and skill base of its local labor force, St. Louis has been identified as one of the leading candidate regions in the nation to be a next top innovation hub, according to a recent study by The Brookings Institution and Information Technology & Innovation Foundation.[1] But to realize this potential, St. Louis needs to specialize in targeted areas of innovation where it can stand out and build competitive advantage at a scale that can impact its broad regional economy.

One such area of innovation, geospatial technologies and applications, has deep roots in St. Louis that had long been overlooked, but is now rising to the fore. St. Louis possesses an extensive base of talent and anchor institutions to be a national leader in geospatial technologies and applications as a platform technology for strengthening leading industry sectors and positioning St. Louis for future growth in the integration of physical and digital worlds, widely known as the Fourth Industrial Revolution.

"Geospatial" refers to the collection and processing of data that is associated with location and spatial analysis for better situational awareness and decision-making. For decades, the use of geospatial technologies and applications had limited commercial markets. But today, geospatial technologies and applications have been unleashed and are becoming a common fabric in our daily lives, with applications such as Google Maps and Yelp!, and in our economy in how companies market their products and services, support customers, manage supply chains and ultimately grow their businesses. Looking ahead, many of the exciting technologies of the future, such as Internet of Things and autonomous systems, will be making use of geospatial-related technologies, locational data and spatial analysis in their basic functioning and applications.

Given the advanced technology nature of the growing uses of geospatial-related applications, locational data and spatial analysis, we have termed this opportunity for St. Louis as the "STL GeoFutures Initiative." The objective of the STL GeoFutures Initiative is to enable the St. Louis region to realize its full potential as a global center of excellence in geospatial-related development. This requires a Strategic Roadmap that brings a community together around a shared vision of the future and what it will take to get there – including an overall situational assessment for positioning the region for success in geospatial development, guiding private and public investments, and providing the real-world operational strategies, tactics and actions designed for implementation and impact.

The term "geospatial" arises from the ability to assemble a range of location-based data into a layered set of maps and other products and applications that integrate boundaries, infrastructure, elevation, geodetic (magnetic and gravimetric), human geography and images



Given the advanced technology nature of the growing uses of geospatial-related applications, locational data and spatial analysis, we have termed this opportunity for St. Louis as the STL GeoFutures Initiative.

1 *Robert Atkinson, Mark Muro and Jacob Whiton, The Case for Growth Centers: How to Spread Tech Innovation Across America, The Brookings Institution and Information Technology & Innovation Foundation, December 2019.*

St. Louis Has Done it Before – The Precedent of the St. Louis Plant and Life Sciences Roadmap

Advancing a cluster Roadmap is not new for St. Louis. Under the leadership of Dr. Bill Danforth and others in the late 1990s, St. Louis pursued a focused cluster strategy that has made the region the global center of excellence for agricultural technology and broader life sciences. This effort made a difference on the ground leading to key organizational efforts, such as BioSTL, BioGenerator and Cortex, that have stood the test of time and sustained an increasingly vibrant life sciences cluster.

The Brookings Institution in its 2018 study on *Rethinking Cluster Initiatives* featured the St. Louis plant and life sciences cluster initiative as one of five best practice examples on the basis of its sustained success in fostering the growth and development. In its in-depth case study of St. Louis as a best practice, Brookings noted some of the key to the success of the St. Louis Plant and Life Sciences Cluster Initiative:[2]

- Created a primary venue for setting the strategic vision of the cluster and fostering a ***"collaborative, trustful environment"*** through the efforts of BioSTL.
- Took a ***broad approach from the very beginning***, with parallel strategies focused on every major area of need: capital, talent, facilities, and networks.
- Made significant progress on each front over the past 15 years, in large part because it had ***"comprehensive approach and patient support including philanthropic capital."***

Much like the plant and life sciences beginnings, we need to collaborate as a community across existing organizations and institutions to create a shared vision that aligns the efforts of many institutions and people over a long time with common goals to create a durable advantage and regional value proposition for the geospatial industry.

This STL GeoFutures Initiative is a key milestone for the St. Louis community, but it is just the beginning of a long journey ahead.

Prosperous regional economies collaborate and invest in their ability to specialize in high-value industries with vibrant, entrepreneurial start-up communities that attract talented people and enterprises. Much like the plant and life sciences community did 20 years ago, the STL GeoFutures Initiative transcends institutions and regional geography to shape a strategy that supports our intention to make St. Louis the nation's leading geospatial hub.

2 *Ryan Donahue, Rethinking Cluster Initiatives: Case Study of St. Louis Agriculture Technology, The Brookings Institution, July 2018.*

Origins of the STL GeoFutures Initiative

Like many regional growth opportunities, there exists a key anchor in the community that has enabled St. Louis to build up its strengths. For the STL GeoFutures Initiative, this anchor is the National Geospatial-Intelligence Agency (NGA). With its approximately 3,700 high-paying jobs, NGA is one of the St. Louis region's largest employers. Remarkably, up until 2017, this base of activity in geospatial-related development was largely unrecognized in St. Louis given the mission of NGA as a critical agency for U.S. intelligence.

But it took a catalyzing event to mobilize the St. Louis community. For STL GeoFutures, this was the competition and decision in 2016 to locate the new $1.7 billion state-of-the-art "Next" NGA West, commonly referred to as "N2W," on a 97-acre site just north of Downtown St. Louis. The headquarters is the largest federal headquarters project in the City of St. Louis.

Now the St. Louis region is coming together as one community to advance geospatial-related development. Among important community-building efforts that have brought key stakeholders together and unified the St. Louis community around geospatial-related development are:

- ***The St. Louis geospatial industry community formed a St. Louis Area Working Group (SLAWG) in June 2017***, as a chartered working group of the U.S. Geospatial Intelligence Foundation, a non-profit organization dedicated to supporting the geospatial industry nationally. SLAWG's initial goal was to bring together regional industry, government, academic and community partners to support education and training pathways and it continues to broaden networking and community-building to support the regional growth of the geospatial industry in St. Louis.

- ***The St. Louis Geospatial Economic Development Roundtable was formed in May 2018 as an outgrowth of SLAWG to bring local economic and other key development leaders together.*** The Roundtable's mission is to foster collaboration and focus among the economic development community to grow and attract geospatial jobs and investment in St. Louis in ways not permitted under the charter with USGIF.

- ***Launching of GeoResolution in April 2019, an annual thought-leadership conference***, hosted by St. Louis University with support from the Roundtable and the NGA. The first annual conference attracted over 600 attendees and participants.

- ***A brand awareness and marketing effort under the banner of "The Future of Geospatial is #STLMade"*** through AllianceSTL at the 2019 Global GEOINT Symposium and has continued with earned media efforts by the St. Louis Development Corporation to elevate the St. Louis geospatial community in local and national media. For 2023 and 2025, St. Louis has been selected for the first time as the host city for the Global GEOINT Symposium.

A Word About the National Geospatial-Intelligence Agency (NGA)

A unique combination of intelligence agency and combat support agency, NGA serves as the world leader in providing timely, relevant, accurate and actionable geospatial-intelligence. By evaluating imagery, maps, charts, multiple layers of foundation data (such as terrain, elevation and gravity) and more, NGA's intelligence specialists help users visualize what is happening at a particular place and time, going beyond describing 'what, where and when' to revealing 'how and why.' NGA's work enables decision-making for policymakers, warfighters, intelligence professionals and first responders.

Source: NGA, approved for public release, 17-466

At the same time, individual institutions and organizations have been hard at work to help advance the ecosystem to support geospatial-related development in St. Louis.

- T-REX, the city's technology incubator located in downtown St. Louis, has established a physical hub for geospatial industry networking, collaboration, innovation and education and training, known as Geosaurus. NGA has a growing presence at T-REX and Geosaurus, and will soon be opening a software development lab for collaborations with leading technology companies and a secured space for classified work with its industry partners.

- Cortex, which is home to many of the larger geospatial companies in the region, is preparing for the increasing need for national cybersecurity and geospatial technologies, with Washington University and Saint Louis University working together to create the Global Center for Cybersecurity @ Cortex and the Geospatial Center @ Cortex.

- Among entrepreneurial support organizations, Arch Grants just announced a major geospatial-focused cohort to attract geospatial entrepreneurs to St. Louis, while Cultivation Capital is organizing a targeted seed fund for emerging geospatial technology ventures. This is in addition to the work that the BioGenerator and Yield Lab do in closely related technology areas of digital/precision agriculture and digital health. And the presence of K-12 STEM activities and workforce development are truly burgeoning, with a wide range of collaborations and organizations involved.

The Strategic Planning Effort of the STL GeoFutures Initiative

The breadth of community engagement and activities underway lays a strong foundation for the STL GeoFutures Initiative. It also makes this a most opportune time to advance a Strategic Roadmap that can link and align stakeholders around a shared vision and action plan.

The key project elements of this Strategic Roadmap have involved:

- Forming a broad stakeholder Advisory Committee of twenty-nine leaders from industry, education, community and economic development communities has come together as one team for St. Louis to guide the development of the Strategic Roadmap.

- Conducting an in-depth and rigorous data analysis of the region's competitive position in geospatial-related development and pathways to growing its geospatial-related industry base. This included:

    - An initial baseline assessment in the Spring and Summer of 2019 as the full planning effort was being organized that took stock of the specific assets found in the St. Louis region around geospatial-related development involving the direct industry base involved in geospatial, skills and talent pipeline, research and innovation and connections to leading industries in St. Louis.

    - A competitive benchmarking analysis considering where the St. Louis region stands in its geospatial cluster development compared to other leading regions.

    - A core competency assessment examining where St. Louis is positioned in the key technologies driving geospatial development and what market opportunities are likely targets for St. Louis to leverage geospatial technologies and applications for growth.

- Engaging in extensive outreach to learn about the activities and perspectives from 95 companies and organizations involved in geospatial-development and broader economic development of the region.

- Hosting six focus group meetings involving 80 participants.

The strategic planning effort for developing the STL GeoFutures cluster Roadmap was conducted over a six-month period, involving monthly meetings of the Advisory Committee to review each step of the project workplan, as depicted in Figure 1 below.

FIGURE 1: OVERVIEW OF STEPS IN STRATEGIC PLANNING EFFORT FOR STL GEOFUTURES

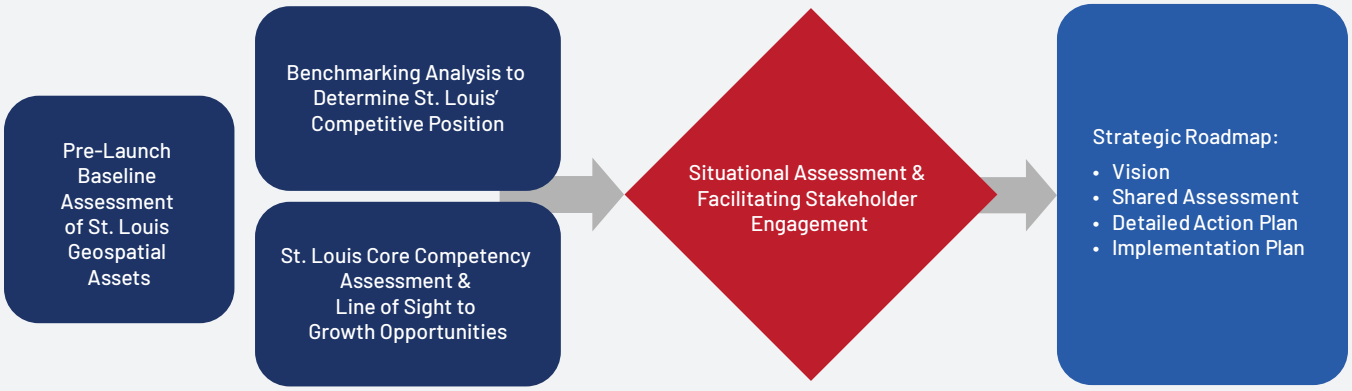


TABLE 1: LISTING OF STL GEOFUTURES INITIATIVE ADVISORY COMMITTEE MEMBERS

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Stacy Hollins, Assistant Dean, Simon School of Business & Associate Professor - Information Systems, Maryville University	Cindy Teasdale, Executive Director, Prepare.ai
Steve Johnson, Chief Executive Officer, AllianceSTL	Steven Ward, Senior Director of Geospatial and Weather Sciences, Climate Corp.
Andy Kersten, Dean, College of Arts and Sciences, UMSL	Bob Wetzel, Vice President, Corporate Development, Enterprise Holdings Ventures
Bobbi Lenczowski, Former NGA Executive	Otis Williams, Executive Director, St. Louis Development Corporation
Emily Lohse-Busch, Executive Director, Arch Grants	

GEOFUTURES

THE STARTING POINT:

CONNECTIONS TO GEOSPATIAL DEVELOPMENT

The Starting Point:

The St. Louis Region's Longstanding Connections to Geospatial Development

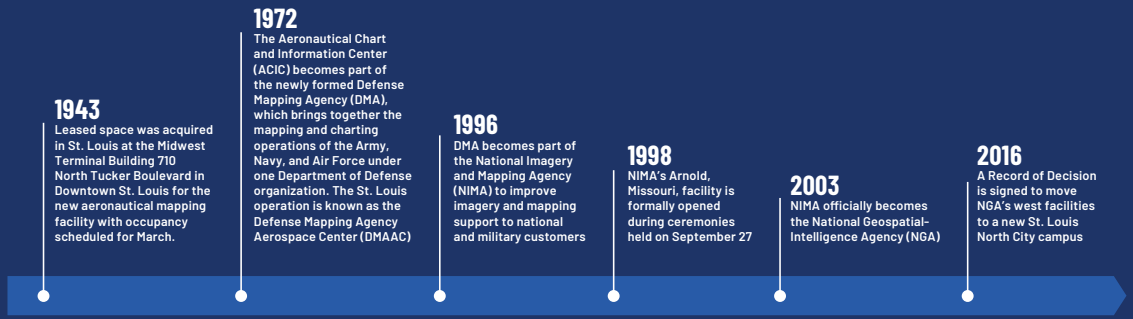
St. Louis has had a profound and prominent place in the history and ongoing activities of geospatial development. Dating back to the Lewis & Clark Expedition, St. Louis has been a gateway for exploration with a legacy of mapping the world around us. With the advent of aerial photography and the demands in WWII for accurate base maps and navigational aids, the science of photographic interpretation and map making took a major leap forward, and once again St. Louis was at the forefront. Beginning in 1943, with the location of the Army's Air Forces Aeronautical Chart Plant, St. Louis has become a leading hub for military map making and locational analysis, now represented by the National Geospatial-Intelligence Agency (NGA) West headquarters.

Given the deep roots of NGA's presence in St. Louis, it should come as no surprise that it plays a broader role in supporting geospatial activities than simply its national security intelligence and combat support missions. One critical and foundational role that NGA in St. Louis carries out is maintaining and enhancing the World Geodetic System. The Earth's geometric shape, orientation in space and gravitational field require constant measurement given hard to detect changes that are critical for accurate and safe navigation and global positioning systems. The World Geodetic System[3] is used not only in defense but for everyday activities from autonomous navigation systems (such as Garmin and Google Maps to flying of commercial airplanes), to digital/precision agriculture, to surveying of sites, to early warning systems of hazards. In addition, through the NGA's activities in St. Louis support is provided under the direction of civilian federal agencies for "first responders" to natural disasters as well as support for Arctic analyses led by the National Science Foundation.

> "After every matter arranged, we left the banks of St. Charles with cheers from the crowd... into unknown civilization ..."
>
> Meriwether Lewis and William Clark
> May 21, Saint Charles, 1804

Today, this longstanding and strong connection to the NGA has anchored the development of a substantial base of economic activity for St. Louis and a broader ecosystem for education and talent development, research and innovation and entrepreneurial development, that can root and sustain long-term economic competitiveness and growth in geospatial development.

MODERN ROOTS TO NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY ACTIVITIES IN ST. LOUIS



Source: National Geospatial-Intelligence Agency, "NGA St. Louis Heritage"

3 *For more information see: NGA Products and Services at www.nga.mil/productsservices/geodesyandgeophysics/pages/worldgeodeticsystem.aspx.*

A Snapshot of Baseline Geospatial Activities Found in St. Louis

A significant economic base of activity and jobs in the region:

- NGA alone employs directly 3,700 workers in the St. Louis region. With salaries averaging $75,000, this stands well above the region's average annual salaries of $54,000.*
- Through NGA's base of defense contractors and other private industries involved in geospatial technologies and applications, such as surveying, logistics, remote sensing and imaging instruments and locational data analysis, there are more than 6,600 jobs across nearly 350 companies in St. Louis. Combined with the nearly $20 million in university R&D grants in geospatial-related research, this generates a total economic impact reaching 27,000 jobs and nearly $5 billion in economic activity for the St. Louis region.

A driver of broader IT and other STEM skills:

- While the modern geospatial workforce continues to include "traditional" occupations and job titles such as cartographer, surveyor, and geographer, the talent base and skill sets are increasingly oriented within "related" IT and data sciences roles such as systems and software engineers, data analysts and scientists, business analysts and design engineers. Some of the top skill requirements in regional geospatial job postings include information systems, programming in Python, data manipulation, and algorithm development, in addition to knowledge of core geosciences—a clear demand for "hybrid" skill sets.
- Taken all together, this geospatial-related occupational workforce in the St. Louis region is large and has grown rapidly since 2015 (up 11 percent) and outpacing national growth to reach nearly 53,000 employed in key geospatial occupations.
- St. Louis' colleges and universities are growing their educational programming and graduate levels in geospatial-related degree fields, increasing graduate levels by nearly 23 percent from 2015-17, a rate more than double that seen nationally.

An emerging area of research and innovation for St. Louis:

- The region's universities conduct nearly $39 million annually in research involving geospatial-related fields, including nearly $20 million in grants with identified geospatial-specific research, and have generated more than 1,300 geospatial research publications in recent years.
- A wide range of university research centers and initiatives involving geospatial technologies and applications are active.
- There have been 14 VC investment deals involving St. Louis geospatial companies since 2015. Local entrepreneur-support organization Arch Grants, which provides $50,000 equity-free grants and pro bono support services to entrepreneurs who locate early-stage businesses in St. Louis, announced in 2019 that it was awarding five additional grants each year specifically to geospatial startups.
- The St. Louis economic development and geospatial communities are mobilizing to create a platform to activate innovation and entrepreneurship in geospatial technologies and applications.

**Note: In the City of St. Louis, NGA presently employs 3,150 workers with an average salary of $101,000.*

The Unfinished Agenda: The Underrepresentation of St. Louis' Black Community in Geospatial and Broader Tech Sectors and the Need to Advance Equity, Diversity, and Inclusion

Despite these significant activities in geospatial development, St. Louis has not been able to realize equitable and inclusive growth through its geospatial activities. St. Louis' geospatial workforce, its university degree programs, and its entrepreneurial community far from reflect the region's diverse population of residents. These findings are backed by regional demographic data analyses, presented here, and have been reinforced consistently in discussions with community leaders and geospatial industry stakeholders during this Roadmap effort.

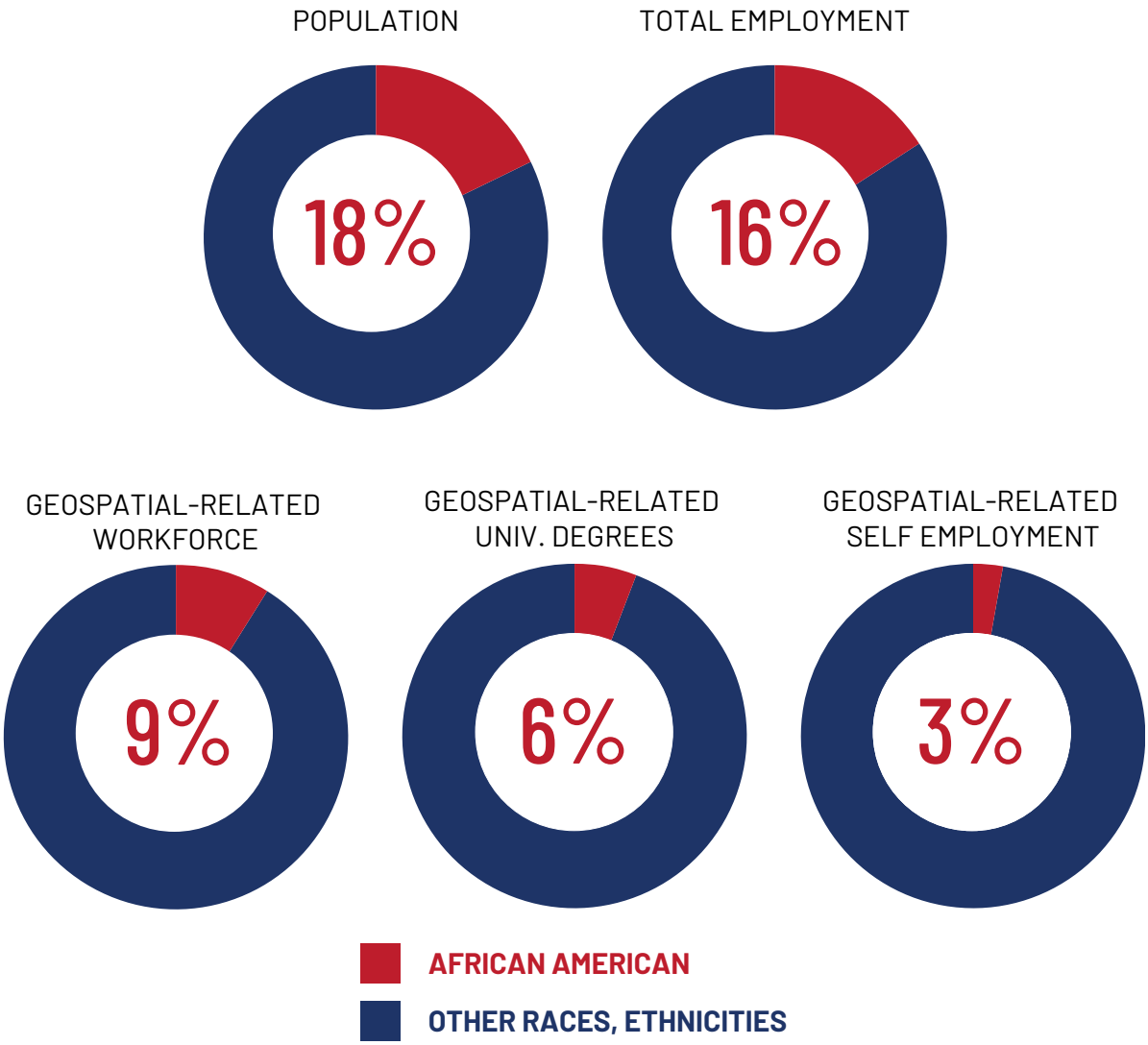
The sector's workforce and talent base—made up of IT professionals, data scientists, engineers and geo-scientists—significantly underrepresents the region's minority community, particularly for African-Americans. In a region where African-Americans make up a greater share of the population compared with the nation—18 percent in the St. Louis metro region compared with 13 percent nationally—their representation in geospatial-related occupational employment measures just half the population share, at 9 percent (see Figure 2). This geospatial share is slightly greater in St. Louis than seen nationally (8 percent).

African-Americans are also significantly underrepresented among graduates of regional geospatial-related college degree programs. Just 6 percent of these graduates are African-American compared with 8 percent nationally. The bright spot in the education ecosystem is that despite the low representation, growth in African-American graduates and other racial/ethnic groups in the St. Louis region are on the rise and outpacing national and broader regional growth (Figure 3).

What is further discouraging for St. Louis is its limited engagement of minority entrepreneurs in geospatial and broader tech development. The share of African-Americans self-employed in geospatial industries stands at just 3 percent in metro St. Louis, and for the broader IT/tech sector, this figure reaches just 4 percent.[4] Moreover, the St. Louis Business Journal reports that none of the region's top venture funding deals last year, for example, involved a company with a Black founder.[5] A survey of Black entrepreneurs by WEPOWER found that 74 percent cited access to capital as a current challenge.[6]

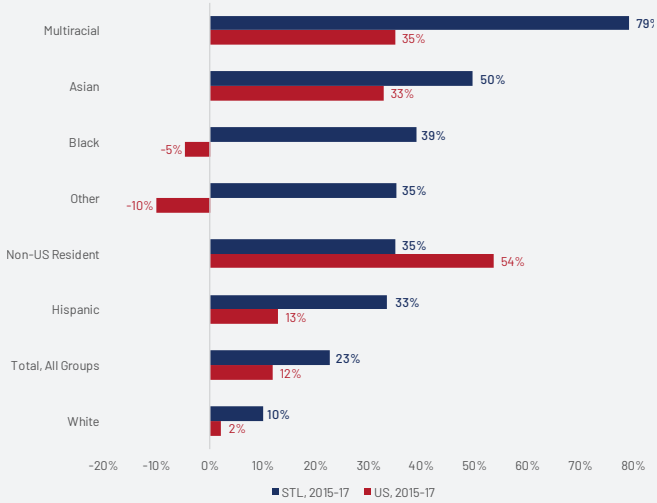
4 *Self-employment estimates were used as a proxy for entrepreneurship here as robust regional "entrepreneurial" data are not available by race, ethnicity.*
5 *"Cultivating a fair ecosystem," St. Louis Business Journal, January 30, 2020.*
6 *WEPOWER, Dream of Change Report.*

FIGURE 2: UNDERREPRESENTATION OF THE AFRICAN-AMERICAN COMMUNITY IN THE REGIONAL GEOSPATIAL ECOSYSTEM



Source: TEConomy Partners' analysis of U.S. Census Bureau population data; EMSI 2019.4 occupational and self-employment data; U.S. National Center for Education Statistics, IPEDS database (degree graduates).

FIGURE 3: TREND IN ST. LOUIS REGIONAL GEOSPATIAL-RELATED DEGREE GRADUATES BY RACE, ETHNICITY 2015-2017



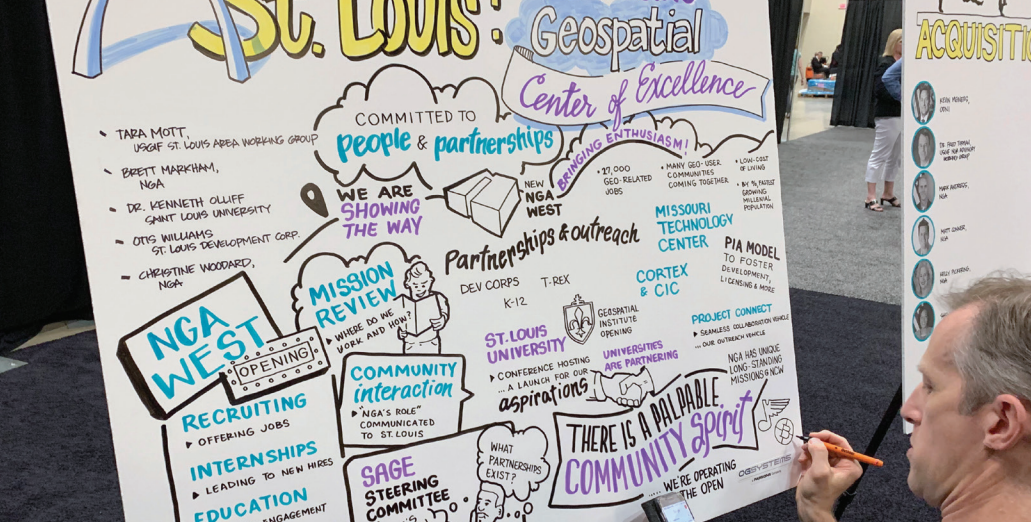
Note: regional degrees include those from institutions within the St. Louis MSA as well as broader region including from MUS&T, Univ. of Missouri-Columbia, Univ. of Illinois-UC.

"Other" racial groups include: "Race unknown", American Indian, Native Hawaiian or Other Pacific Islanders.

Source: TEConomy's analysis of U.S. National Center for Education Statistics, IPEDS database.

In a region hungry for and competing on geospatial and broader tech talent, this lack of inclusion and engagement of the region's Black and other racial and ethnic minority populations in the industry represents not only an economic concern, but also a legitimate moral one that reflects decades of racial disparities and economic inequalities more broadly. The community has identified these themes consistently during this Roadmap effort, citing a legacy in St. Louis of a lack of emphasis on meeting the needs of distressed communities and addressing racial equity. These themes and challenges are affirmed in the analysis of the geospatial industry and its regional talent pipeline.

And yet these significant regional challenges offer an opportunity to focus this geospatial development strategy on helping to address this "unfinished agenda" in the region of racial equity. The NGA's huge investment in North City neighborhoods and the resources leveraged in this strategic effort can and must advance progress on these challenges. The STL GeoFutures Initiative must build into its vision for St. Louis explicit and intentional approaches to addressing these challenges, particularly for the North City residents and their children who will observe first-hand the region's "GeoFuture" in their neighborhood. The question is, how do we make sure they are part of it?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SHOWING
THE WAY
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NGA
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Partnerships & outreach
MISSION
REVIEW
COMMUNITY
interaction
NGA
WEST
OPENING
RECRUITING
INTERNSHIPS
EDUCATION
SAGE
STEERING
COMMITTEE
MISSOURI
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& CIC
PIA MODEL
ST. LOUIS
UNIVERSITY
PROJECT CONNECT
THERE IS A PALPABLE
COMMUNITY spirit
ACQUISITI

THE FUTURE OF GEOSPATIAL IS
STLMADE

JIM
EXHIBITOR
STLMADE

THE FUTURE OF GEOSPATIAL IS
STLMADE
START UP | STAND OUT | STAY

STL
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START UP | STAND OUT | STAY
STAY

START UP
STAND OUT
St. Louis is among Forbes' Top 10 rising cities for start-ups
THE FUTURE OF GEOSPATIAL IS
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THE FUTURE OF GEOSPATIAL IS
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THE FUTURE OF GEOSPATIAL IS
STLMADE
START UP | STAND OUT | STAY

GEOFUTURES

STL GEOFUTURES FORWARD-LOOKING OPPORTUNITIES

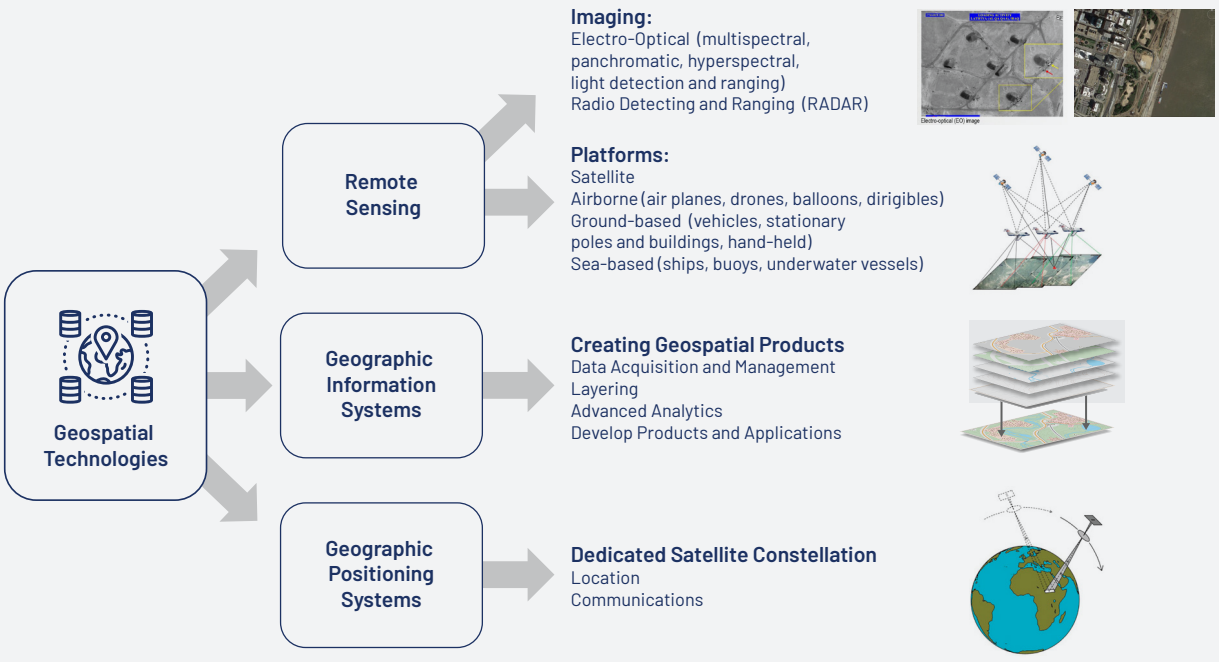
The Forward-Looking Opportunities for STL GeoFutures

> *"Everything happens somewhere. Over the past many years, the ability to understand the "where" aspect of our everyday lives has become increasingly powerful."*
>
> Geospatial World, 2018

Setting the Context: Geospatial Technologies and Applications Offer a Pathway to Transformative Innovation Growth

Geospatial development has come a long way from simply making maps. The advent of today's ubiquitous use of locational data can be traced to the late 19th century and early 20th century when cartography and mapmaking were joined by aerial photography as early cameras were sent aloft on balloons and pigeons, and then on airplanes. The science and art of photographic interpretation and map making was accelerated during WWII. Since the Cold War, geospatial technologies have taken on new dimensions with the advent of satellites, remote sensing technologies and geographic information systems into robust uses of locational data (see figure on Depiction of Geospatial Core Technologies).

FIGURE 4: DEPICTION OF GEOSPATIAL CORE TECHNOLOGIES



Today, the geospatial marketplace involves a rich assortment of technology-based solutions, such as global positioning systems, earth observation, 3D scanning and spatial analytics. Altogether the geo-spatial market is large and growing fast. The research firm, MarketsandMarkets, estimates the geospatial market at $239.1 billion in 2019 and growing to $502.6 billion by 2024, a 13.2 percent compound annual growth rate over this five-year period.[7]

What makes geospatial transformative is how locational data has become integrated into digital applications. Applications using locational data are now ubiquitous on smart phones helping people make decisions from how to drive to where to eat, all in real time. For industry, the 'where' dimension is redefining how businesses operate, with locational data now being a key component for how businesses understand their assets, operations, transactions, human resources, and customers.[8] The industry applications of geospatial technologies and data are now expanding into almost every market and enabling a high level of operational efficiency, customer services and product offerings. Examples of this broad reach of geospatial applications are noted in Figure 5.

FIGURE 5: BROAD MARKET REACH OF GEOSPATIAL APPLICATIONS

Logistics and transportation services to track vehicles, maximize efficiency of routing, and inventory management;

Retail services to reflect different consumer tastes and anticipated purchases based on changing weather patterns;

Digital/Precision Agriculture to enable a farmer to optimize and customize the timing, amount, and placement of inputs such as seed, fertilizer, pesticides, and irrigation to produce the maximum yield at the lowest cost; and

Financial services to manage real estate investments, monitor possible fraud activity, and provide insights to target customers.

7 *MarketsandMarkets, Geospatial Solutions Market by Technology, Solution, End-User, Application and Region – Global Forecast to 2024, see https://www.marketsandmarkets.com/Market-Reports/geospatial-solution-market-206125202.html?gclid=EAIaIQobChMI9KK9h-rM5wIVHYVaBR16ug-MoEAAYASAAEgLhqfD_BwE.*

8 *For a good discussion of how location data are redefining business data/processes, see 2019 GEOBUIZ section on "Location and Business Intelligence Market."*

Beyond the value of applications of locational data, it is the convergence with advanced computing and data sciences that makes geospatial-related development such a powerful growth engine. The next wave of digital technologies from Internet of Things to artificial intelligence to autonomy are integrally linked to geospatial technologies and data. For instance, geospatial remote sensing and positioning technologies are critical to autonomous vehicles and drones, with location data enabling their operation along with more informed decisionmaking using machine learning algorithms. In addition, the rise of the Internet of Things will make the use of persistent and targeted geospatial data available to better manage our lives, and the use of geospatial data is driving the adoption of virtual reality to better model behaviors along with unique geospatial machine learning algorithms.

Looking to the future, geospatial development is shaping up to be a key enabler of the Fourth Industrial Revolution, in which the merging of physical and digital worlds fundamentally changes the way we live, work and relate to one another. More specifically, the Fourth Industrial Revolution refers to how technologies like artificial intelligence, autonomous vehicles and the internet of things are merging with humans' physical lives. Consider as examples voice-activated assistants, facial ID recognition or digital health-care sensors.[9]

> *"This Fourth Industrial Revolution is characterized by a range of new technologies that are fusing the physical, digital and biological worlds. The impact is profound as this revolution is evolving with greater velocity, affecting various industries, economies, and countries across the world and calling for a total overhaul of the existing systems and processes."*
> **— Professor Klaus Schwab, Founder and Executive Chairman, World Economic Forum**

Geospatial technologies and applications are integrally related to the Fourth Industrial Revolution. The need for real-time locational data for decision-making and situational awareness will accelerate under the Fourth Industrial Revolution. This will involve cutting-edge technologies such as remote imaging and sensing, smart devices in cyber-physical systems, autonomous systems and Big Data predictive analytics powered by artificial intelligence and machine learning to drive innovations in our daily lives.

So, geospatial development is not just a narrow set of technologies and applications, but a fundamental and enabling part of the larger digital transformation taking place in the decades ahead (see Figure 6).

TECHNOLOGY PLATFORMS FOR GEOSPATIAL MARKETS

Global positioning systems involve a network of satellites and receiving devices used to determine the location of something on Earth and have become a common tool used for navigation with GPS-enabled smartphones. Increasingly integrated into smart mobility applications for uses such as fleet management and road traffic monitoring.

Earth observation involves use of satellites to observe changes with the planet from temperature to forestation to ice sheet coverage using advanced imaging technologies.

3D Scanning digitally captures the shape of an object using laser light and is used for high-resolution mapping. These scanners, originally developed for as-built modeling of architectural and engineering structures, can also be used for high-resolution mapping of terrain, vegetation, and other landscape features over limited distances in the range of 50 to 300 m.

Geographic information systems and spatial analytics provides modeling, trend analysis and predictions based on data generated from global position systems georeferencing, and remote sensing.

9 *Elizabeth Schulze, "Everything you need to know about the Fourth Industrial Revolution," CNBC, January 22, 2019, see: https://www.cnbc.com/2019/01/16/fourth-industrial-revolution-explained-davos-2019.html.*

FIGURE 6: CONVERGENCE OF GEOSPATIAL WITH DIGITAL REVOLUTION

"With the onset of a digital revolution in which the 'where' dimension is becoming fundamental to all decision-making, geospatial has emerged as an enabler of the entire digital space. Smartphones in every hand and advancements in computing technologies, aerospace platforms, sensors and digital communications have steered the growth and expansion of geospatial industry into new and varied applications. The continuous growth in digital infrastructure and digital technology ecosystem of Artificial Intelligence, Internet of Things, Big Data, and Cloud is further accelerating the geospatial industry's global reach and contribution."

- 2019 Edition of GeoBuiz

Technologies Accelerating Geospatial Industry Growth						
	Big Data	**Cloud**	**Artificial Intelligence (AI)**	**Internet of Things (IoT)**	**Wireless & Broadband**	**Cybersecurity**
Future Imperatives	As the amount of spatial and non-spatial data being captured increases from the network of smart devices, new business models and services will transform the way we interact and transact.	It will play a crucial role in the emergence of platform technologies and business models that would greatly impact the market of analytics, e-commerce, navigation, engineering, etc., wherever data has a spatial dimension.	Expected integration of AI with geospatial technologies will pave the way for better workforce automation and process management.	Exploitation of the location data component from IoT systems are dramatically impacting the market of geospatial technologies, especially GIS/Spatial Analytics and Global Navigation Satellite System (GNSS).	Its impact on empowering citizens is expected to expand further in the future as developing countries prepare the necessary infrastructure to bridge the digital divide.	Cybersecurity protections for geospatial systems are closely linked to needed advances for securing connected smart devices and infrastructure, including protecting remote sensing platforms. In turn, it is expected that geospatial analysis will contribute to detecting and responding to cyber attacks. There are also concerns about individual privacy and the need to protect geospatial data with the ability to digitally map our physical movements in real time.

Source: GeoBuiz, 2018.

Positioning St. Louis for Future Transformative Growth through Geospatial Development

The longer-term opportunity for St. Louis through the STL GeoFutures Initiative is to fully participate and take a leadership role in the Fourth Industrial Revolution. The analysis undertaken for the Strategic Roadmap addresses how St. Louis can get there.

Fundamental to the Strategic Roadmap effort is assessing ***"where is St. Louis positioned in the key technologies driving geospatial development"*** and ***"what market opportunities are likely targets for St. Louis to leverage geospatial technologies and applications for growth?"***

The approach for this assessment involved three steps:

NATIONAL FOOTPRINT ON GEOSPATIAL TECHNOLOGIES AND APPLICATIONS

To inform the STL GeoFutures Initiative, a detailed innovation landscape analysis for geospatial development was prepared. It includes a wide variety of data on innovation activity—including patents, venture capital funding and research publications—to provide a comprehensive view of innovation taking place across industry, universities and federal labs. The methods used to analyze innovation activity focused on using advanced machine learning analytics appropriate to each of the innovation data sources, as described below.

The overall results found that the networks and clusters involving geospatial innovation across patents, venture capital and research publications represent highly integrated, end-to-end systems that contain embedded sensing, data management and analytics technologies whether involving specific applications or spatial data and analytical tools.

Among patent innovations, which stands as the primary way in which inventors based in industry, universities/non-profit labs and federal agencies are able to protect their innovations for commercialization, TEConomy identified 21,773 U.S.-invented patents from 2015 through mid-2019 in key geospatial-related areas such as navigational systems, satellite positioning, imaging technologies and geolocation applications. A patent activity network analysis revealed major themes in innovation that involved integrated systems providing end-to-end solutions. So, individual classes of patents were not sufficient to drive innovation. Instead, the integration of sensing, data intake, processing, analysis and end-user interfaces linked patents together.

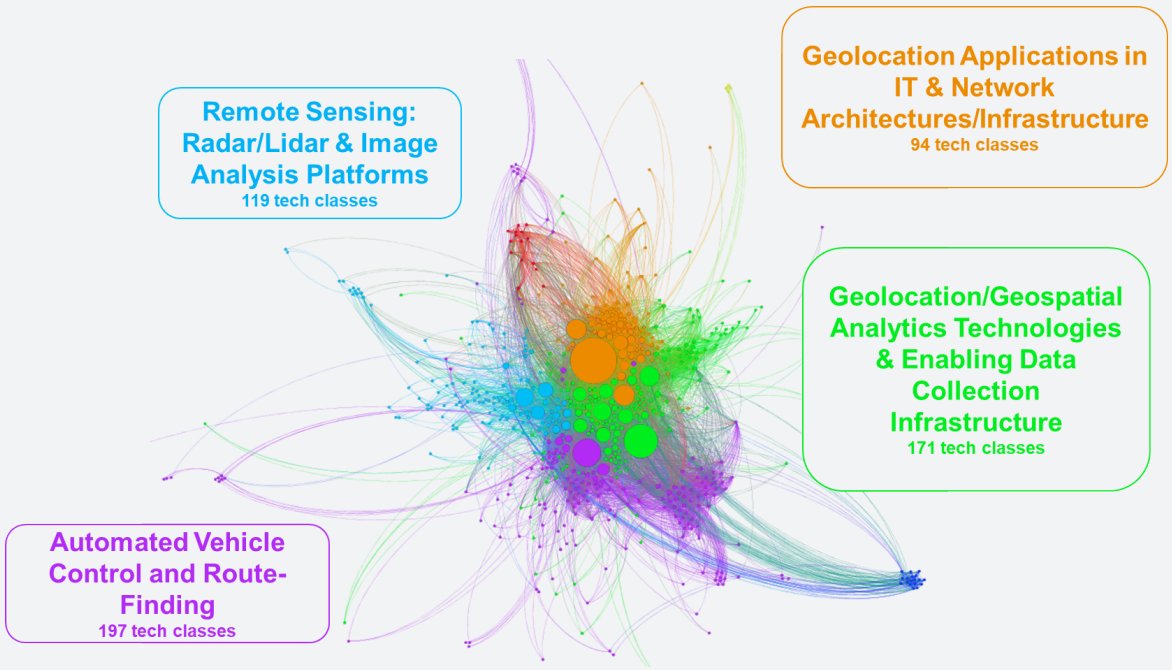
This finding was revealed by examining the linkages in co-occurring technology classes in patent records to find convergent or combination technology themes. Four major themes emerged, each requiring integration of many patent technology classes, involving:

- Automated vehicle control and route finding, involving 197 technology classes;
- Remote sensing and image analysis platforms, involving 119 technology classes;
- Geolocation applications in IT and network architectures and infrastructure, involving 94 technologies classes; and
- Geolocation and geospatial analytics and enabling data collection infrastructure, involving 171 technology classes.

Similarly, among venture capital-backed geospatial startup companies, which represent those advancing innovations with high growth potential to generate sizable returns on risk-oriented equity investments, a cluster analysis of 889 U.S. venture capital-backed companies funded since 2015 analyzing the unstructured text of detailed company descriptions found three broad themes across 16 innovation clusters with common technology or market application focus, including:

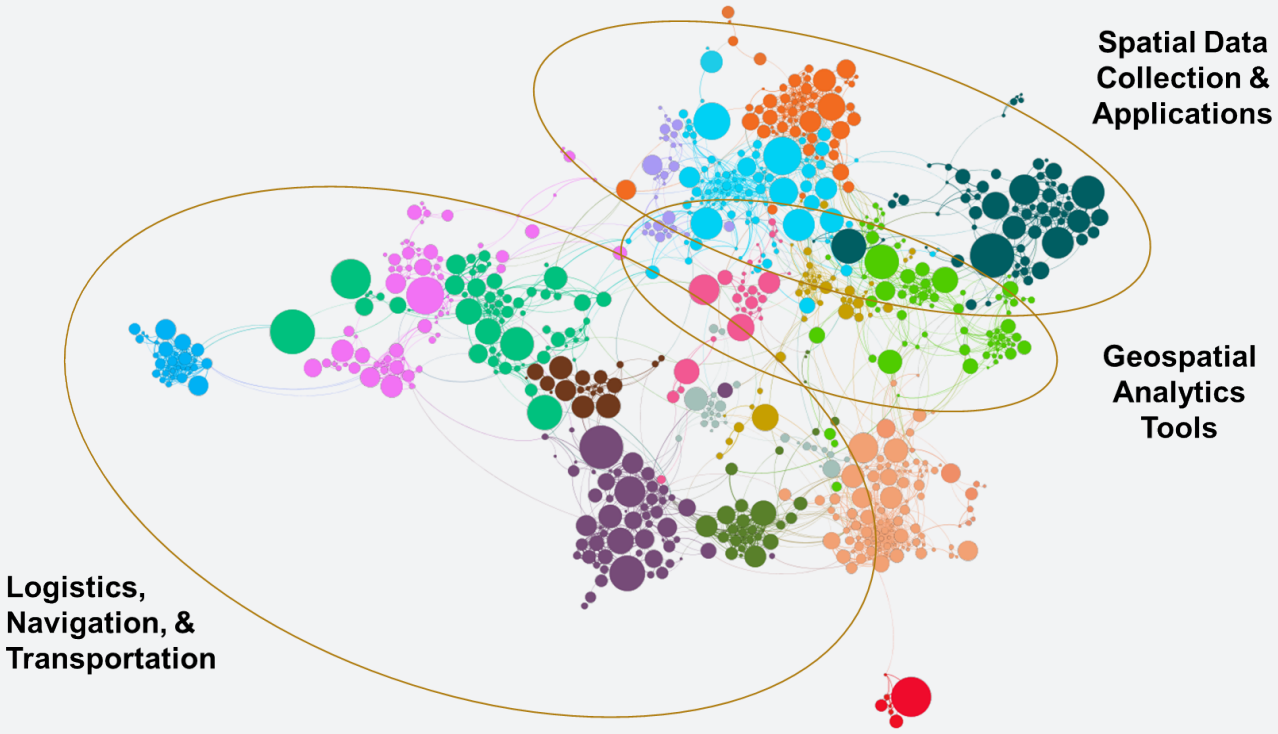
- A logistics, navigation and transportation theme, involving innovation clusters dealing with fleet management and freight logistics, food delivery, on-demand delivery platforms, vehicle telematics, autonomous vehicle sensing systems, robotic systems position finding and navigation and drone management platforms;
- A geospatial analytics tools theme, involving innovation clusters dealing with software solutions, navigation tools and platforms and georeferencing and location sharing software solutions; and
- A spatial data collection and applications theme, involving innovation clusters dealing with marketing and customer experience geoanalytics, infrastructure and real estate mapping, public safety and healthcare device geolocation, augmented reality platforms, integrated satellite and remote sensing platform and spatial intelligence platform and services.

FIGURE 7: PATENT ACTIVITY NETWORK ANALYSIS MAPPING OF GEOSPATIAL-RELATED PATENTS, 2015 TO MID-2019



Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

FIGURE 8: VENTURE CAPITAL-BACKED GEOSPATIAL COMPANY INNOVATION CLUSTERS, 2015 TO MID-2019

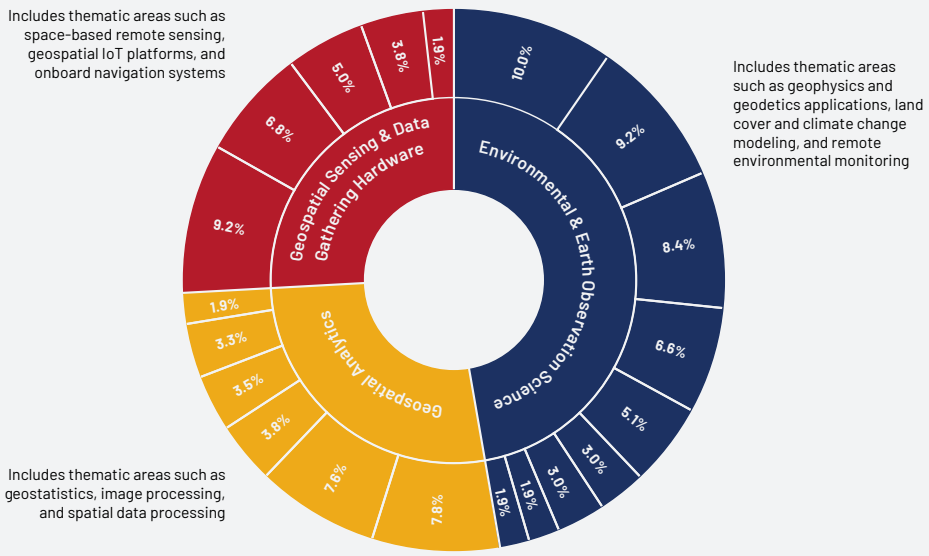


Source: TEConomy Partners' analysis of PitchBook Venture Capital data.

Meanwhile, an analysis of the unstructured text from 35,188 peer-reviewed publication abstracts in geospatial-related research areas since 2015, which represents scholarly activity taking place in research primarily found at universities, federal labs and other non-profit labs, offered a less commercial and more basic research view of geospatial applications, but still focused on more integrated solutions involving three broad themes:

- Environmental and earth observation including innovation topics in areas such as geophysics and geodetics applications, land cover and climate change modeling, and remote environmental modeling;
- Geospatial sensing and data gathering hardware, including innovation topics in areas such as space-based remote sensing, geospatial Internet-of-Things platforms and onboard navigation systems; and
- Geospatial analytics, including innovation topics in areas such as geostatistics, imaging processing and spatial data processing.

FIGURE 9: TOPIC ANALYSIS OF GEOSPATIAL-RELATED PUBLICATIONS, 2015 TO MID-2019



Source: TEConomy Partners' analysis of Web of Science publications database.

A closer analysis, particularly of patents and venture capital-backed companies, finds that advanced computing and data sciences are key enabling technologies that are central in linking together these more integrated solutions involving geospatial-enabled systems and applications and spatial data and analytical tools.

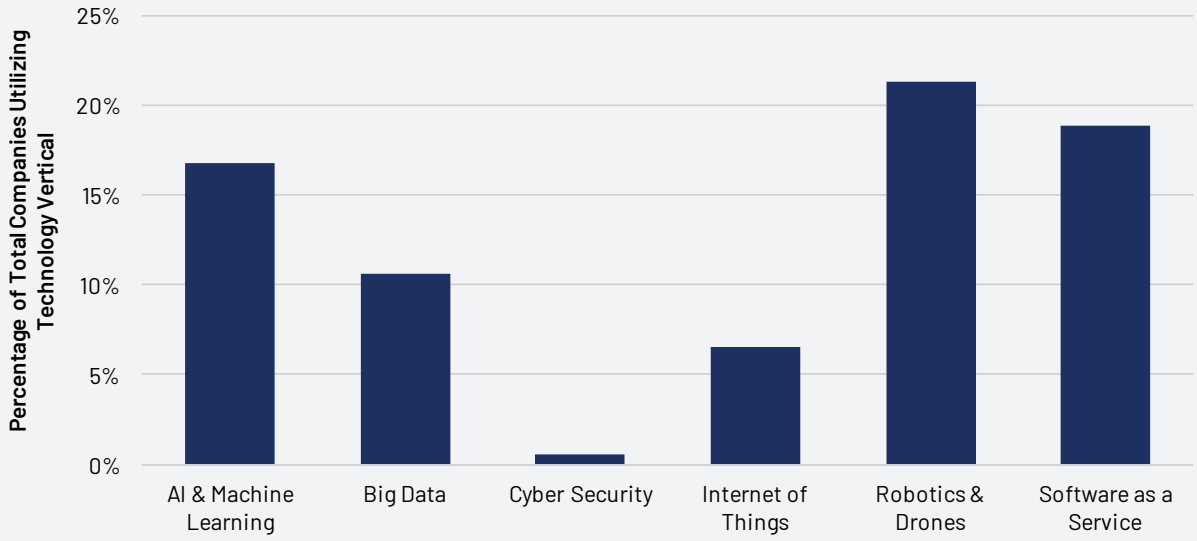
In the geospatial patent innovation networks, the centrality of advanced computing and data sciences was measured directly based on which patent classes are the leading connectors throughout the patent network structure. What stands out as most central across the four themes in linking the patent networks together are patents involving IT systems, data analytics, wireless communications and user interfaces (see Table 2).

TABLE 2: PATENT ACTIVITY INNOVATION NETWORK CENTRALITY MEASUREMENT

Broad Technology Class Description	Network Centrality Measure (maximum = 1.0, minimum = 0.0)
Services specially adapted for wireless communication networks	1
Digital user interfaces	0.92
Networked application-specific arrangements or communication protocols	0.91
Data Processing & Systems for Administration; Management	0.83
Data Processing & Systems for Commerce, e.g. shopping or e-commerce	0.83
Traffic control systems for road vehicles	0.82
Information retrieval from databases and file systems	0.8
Methods for recognizing characters or for recognizing patterns	0.78
Data systems for a specific business sector, e.g. utilities or tourism	0.76
Network architectures or communication protocols for network security	0.73

Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

FIGURE 10: TECHNOLOGY VERTICALS OF U.S. GEOSPATIAL-RELATED VENTURE-BACKED COMPANIES, 2015 - PRESENT



Source: TEConomy Partners' analysis of PitchBook Venture Capital data.

For venture capital-backed geospatial companies, the enabling role of advanced computing and data sciences is revealed by considering the underlying "technology" verticals being advanced by geospatial-technology companies with AI & Machine Learning, Big Data, Internet of Things, Robotics & Drones (autonomy) and Software-as-a-Service standing out (see Figure 10).

Figure 11 depicts the overall assessment of the innovation landscape around geospatial technologies in which highly integrated solutions for geo-enabled applications and spatial data and analytical tools are enabled by advanced computing and data sciences technologies. This analysis then confirms that to be a national leader in geospatial development will require possessing deep competencies and know-how in advanced computing and data sciences fields to advance both the geospatial tools and applications.

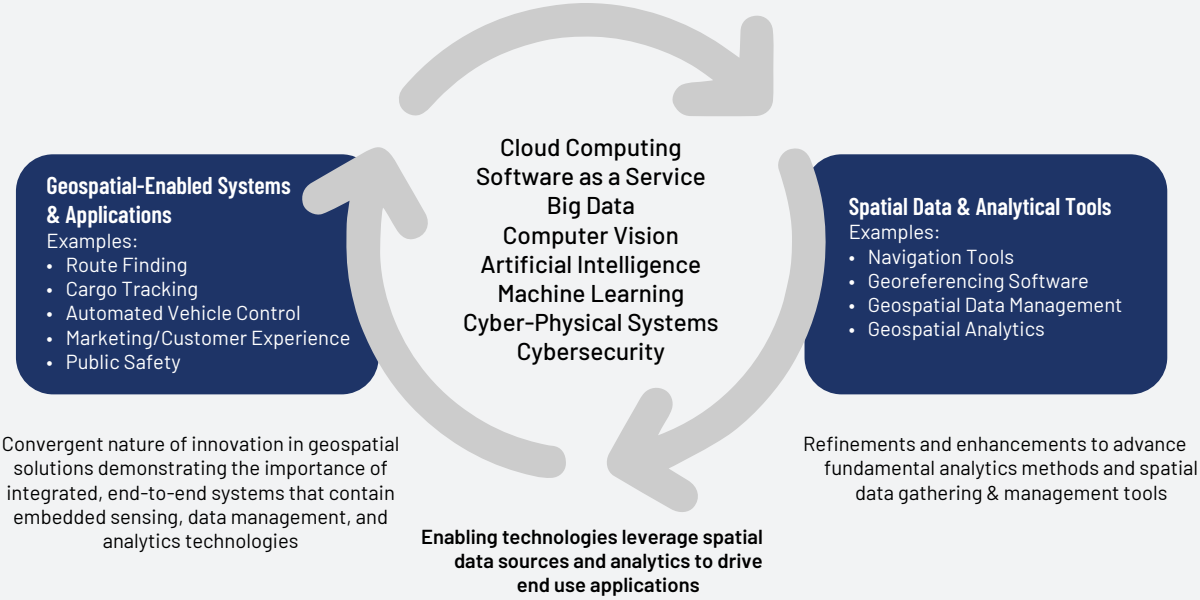
ST. LOUIS' POSITION WITHIN BROADER ENABLING TECHNOLOGIES INVOLVED WITH ADVANCED COMPUTER AND DATA SCIENCES

When considering St. Louis, it is established that there is a significant base of companies and workforce involved in geospatial activities, primarily related to national security and anchored by the presence of the NGA West headquarters.

Where St. Louis is not as strong is in its base of activities around geospatial innovation, across patents, venture-backed companies and publications:

- 0.7 percent or 241 geospatial publications out of 35,188 across the U.S. since 2015.
- 0.4 percent or $38.8 million in geospatial-related research expenditures compared to $9.1 billion for all universities in the U.S.
- 0.3 percent or 58 geospatial patents out of 21,773 invented since 2015 had St. Louis regional inventors.
- 0.8 percent or 7 geospatial venture capital-backed companies out of 889 were funded in St. Louis.

FIGURE 11: SUMMARY DEPICTION OF THE NATIONAL LANDSCAPE OF GEOSPATIAL INNOVATION



Source: TEConomy Partners' analysis.

By comparison, the St. Louis region accounts for 1.9 percent of all U.S. job openings requiring geospatial-related hard skills and knowledge during the 3-year period from October 2016 through October 2019. Further, the region accounts for 1.0 percent of all U.S. college and university graduates in geospatial-related degrees in 2017.

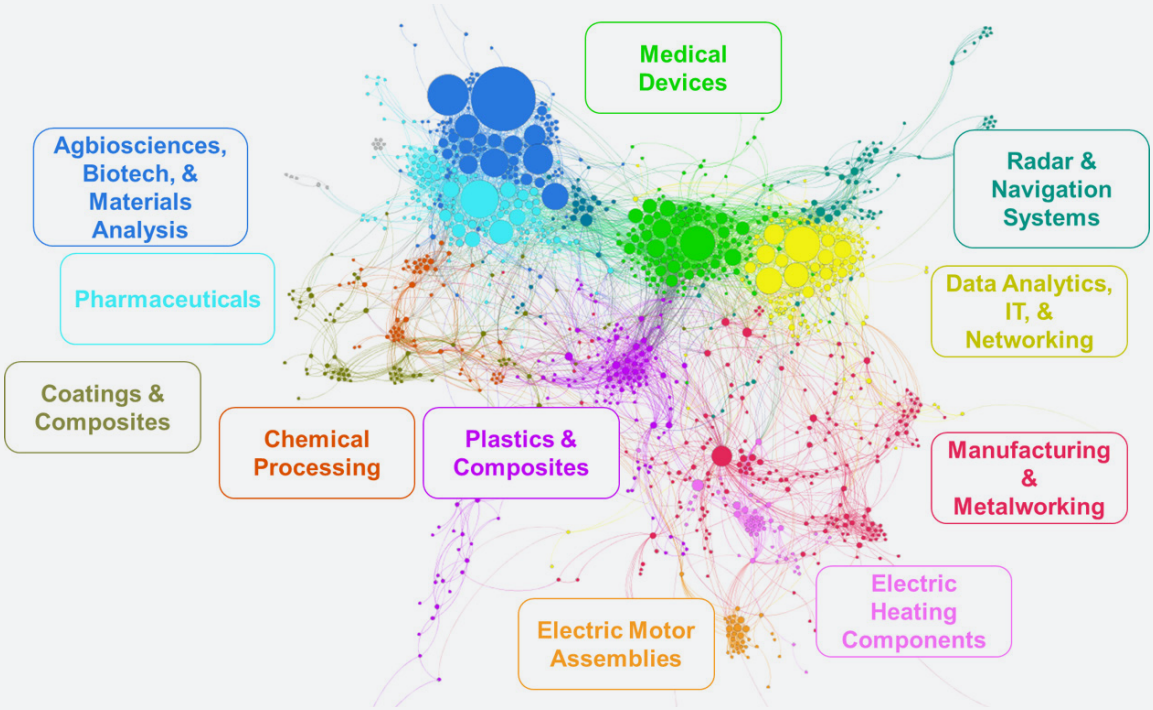
What is important to consider is whether St. Louis has the potential in advanced computer and data sciences even if it is not currently linked to geospatial innovations. Here the answer is a strong "yes".

An overall innovation landscape assessment of St. Louis across all of its patents, publications and venture capital identified focused clusters of innovation taking place in advanced computing and data sciences.

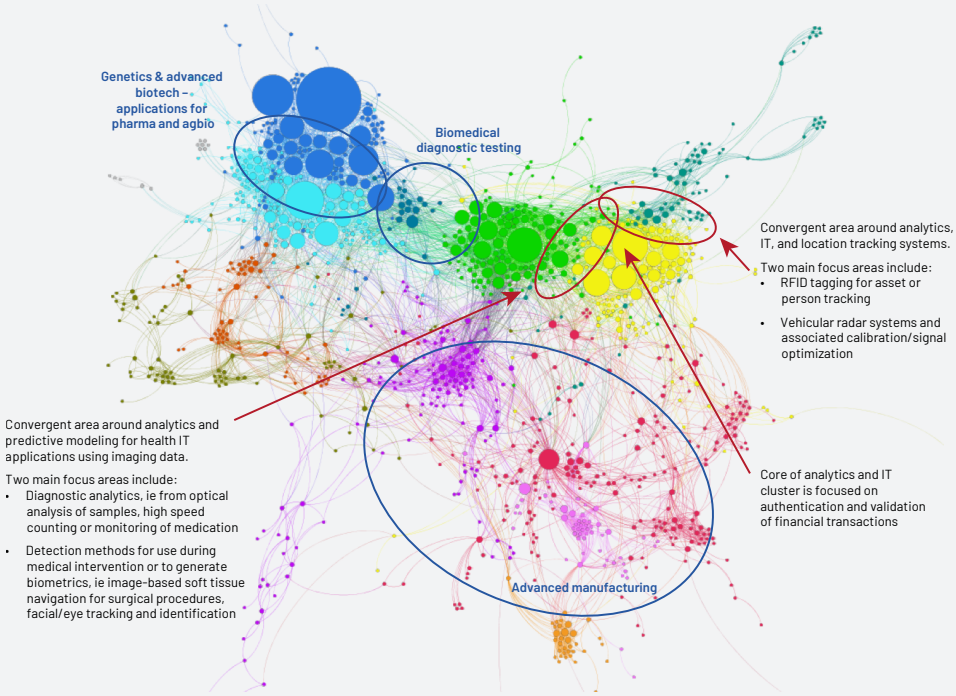
A patent innovation network mapping across all patents invented in St. Louis since 2015, involved 8,206 patents and a number of core network activities stand out in areas such as agbiosciences, medical devices, pharmaceuticals, and advanced manufacturing, but also a distinct network of IT and analytics applications (see Figure 12). What is interesting about this analytics and information technology network is that while its primary focus is on authentication and validation of financial transactions, reflecting the strong base of financial services companies in the St. Louis region, it also is a highly convergent network with key linkages into digital health, including analysis of imaging data, and location tracking systems. This is very promising for future geospatial innovation since it shows a distinct competency in St. Louis around analytics and information technology that is already involved in image analysis and location tracking – two critical core competencies needed for geospatial innovations.

FIGURE 12: PATENT INNOVATION NETWORKS FOR ST. LOUIS ACROSS ALL PATENT ACTIVITIES, BY ALL MAJOR NETWORK GROUPINGS AND CONVERGENCE OF DATA ANALYTICS/INFORMATION TECH NETWORK ACROSS OTHER MAJOR NETWORK GROUPINGS, 2015 TO MID-2019

Overall Patent Network Map with Major Network Groupings



Focused Look at Convergence of Analytics and IT Network



Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

In publications activity, a cluster analysis focused on topic areas across the unstructured text of publication abstracts found that 15 topics, involving more than 16 percent of all publications from St. Louis universities since 2015, were focused on enabling technologies of data sciences, imaging, remote sensing, computer sciences, and associated hardware/infrastructure that could be leveraged towards geospatial applications (see Table 3). So, while not a national powerhouse in advanced computing and data sciences, there are clear areas of critical mass in specific topics demonstrating a breadth of core competencies.

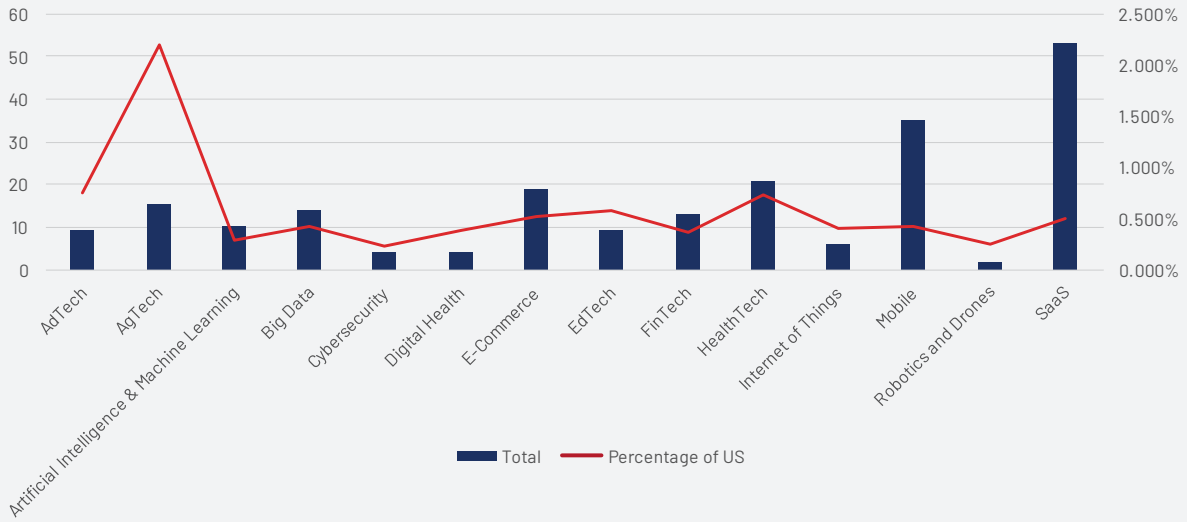
In venture capital activity, an analysis of all technology verticals developed by PitchBook found a strong concentration in St. Louis venture capital activity in advanced computing and data sciences technologies (see Figure 13). Ten or more St. Louis venture-backed companies receiving funding since 2015 are involved in advanced computing and data sciences technology fields, including: software as a service (SaaS) with 53 companies; mobile applications with 35 companies; health tech, including health IT, with 21 companies; E-commerce with 19; agricultural tech with 15 companies; Big Data with 14 companies; financial tech (FinTech) with 13 companies and artificial intelligence/machine learning with 10 companies. Still, the highest shares of national activities were found in AgTech, AdTech and HealthTech, which are all important areas that relate to applications of geospatial analysis as discussed below.

TABLE 3: ADVANCED COMPUTING AND DATA SCIENCES PUBLICATION TOPIC AREAS IDENTIFIED FROM CLUSTER ANALYSIS OF PUBLICATION ABSTRACTS, 2015 TO MID-2019

Topic Area	Prevalence in Publications (average prevalence = 1.0%)
Adaptive algorithms & reinforcement learning – allocation, optimization, & adaptive control applications	1.9%
Electromagnetic sensing components & materials	1.5%
Climate change effects modeling – includes aspects of precision ag & geospatial data analysis	1.4%
Image processing & classification methods – includes both remote sensing & biomedical applications	1.2%
Lithospheric modeling – includes 3D modeling, remote imaging, & signals analysis applications	1.1%
Bioinformatics & precision medicine – high performance computing for large scale analysis, drug discovery	1.1%
Mobile cloud computing architecture & applications	1.0%
Statistical estimation and prediction models	1.0%
Imaging technology applications – wide variety ranging from astrophysics to biomedical using spectroscopy, electromagnetic, & other optical data	1.0%
Web-based tools & infrastructure – some presence of edge computing & IoT frameworks, web-based apps for healthcare & education	0.9%
Observational cosmology studies – spectroscopy, photometry, x-ray & other imaging techniques	0.9%
Cyber security – mixed applications including authentication protocols, biometrics, cyber-physical systems	0.9%
Pollution & particulate matter exposure – some spatial context to data gathering & modeling	0.9%
Predictive modeling applications – mostly biomedical context	0.8%
Medical imaging – MRI/PET/CT scan enhancement methods, improved imaging/contrast agents	0.7%

Source: TEConomy Partners' analysis of Web of Science publications database.

FIGURE 13: VENTURE-BACKED COMPANIES IN ST. LOUIS BY TECHNOLOGY VERTICALS, BY NUMBER AND SHARE OF U.S., 2015 TO MID-2019



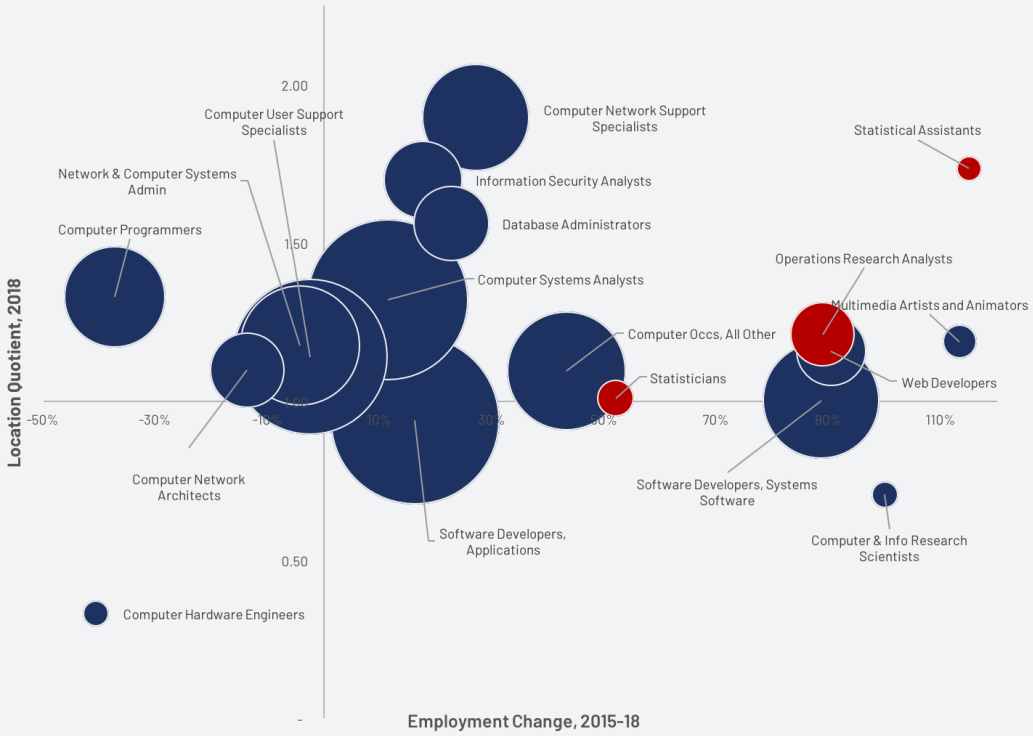
Source: TEConomy Partners' analysis of PitchBook Venture Capital data.

Additionally, the talent base found in St. Louis workforce demonstrates broad skills in IT and data sciences. St. Louis stands well above the national level of employment concentration in overall information technology/computer-related jobs with a 16 percent greater concentration of jobs compared to the national average. In specific IT occupations the region also has a much higher concentration than the nation and so is considered "specialized", including for information security analysts, network support specialists, database administrators, computer programmers, and systems analysts. On the bubble chart in Figure 14 these occupations are well up the vertical axis with a location quotient that exceeds 1.20 or at least 20 percent greater than the national average. In addition, the growth of IT occupations overall and among several of these key specialized occupations is growing fast in St. Louis.

For data sciences occupations, St. Louis stands well above the national average concentration at 18 percent more concentrated, is growing rapidly at 86 percent since 2015 and exceeds the national growth rate of nearly 11 percent (Figure 15). This indicates that St. Louis is gaining market share and if this trend continues will further exceed the national concentration in years to come.

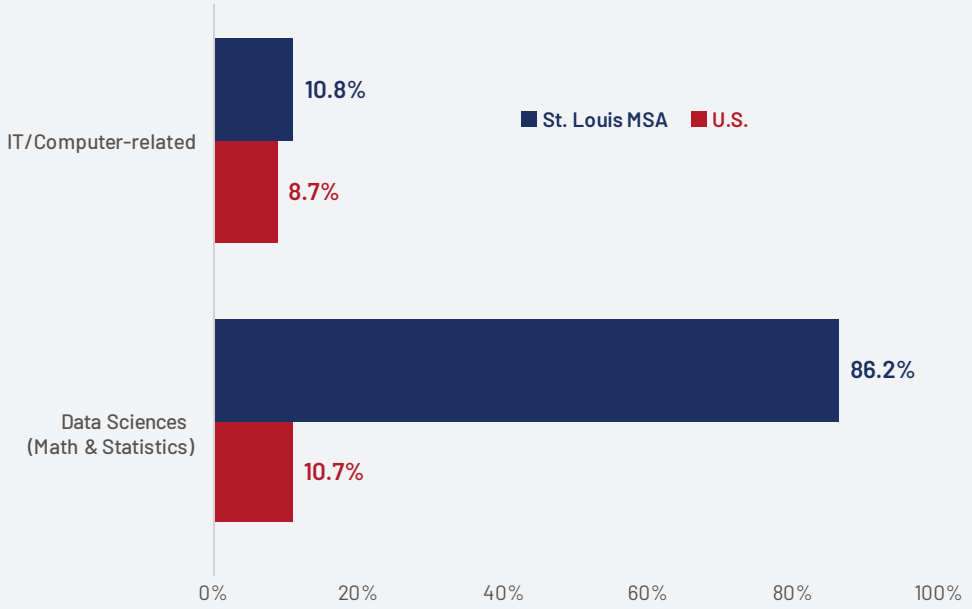
So, this assessment of broad measures of innovation-activity taking place in St. Louis as well as the talent base of the workforce points to the capabilities of St. Louis focusing on advanced computing and data sciences needed for geospatial innovations into the future. The challenge is how to tap these competencies of future geospatial innovation activities.

FIGURE 14: IT AND DATA SCIENCE OCCUPATIONAL EMPLOYMENT:
SIZE, DEGREE OF SPECIALIZATION, AND RECENT GROWTH TREND FOR ST. LOUIS METRO REGION, 2015-18



Note: Size of bubble = employment level in the St. Louis region.
Blue bubbles indicate IT/computer-related occupations; Red bubbles indicate data sciences (math and statistics).
Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, Occupational Employment Statistics data.

FIGURE 15: EMPLOYMENT GROWTH IN OVERALL IT AND DATA SCIENCES OCCUPATIONS—
ST. LOUIS VS. U.S., 2015-18



Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, Occupational Employment Statistics data.

A Path Forward for St. Louis – Focus on Being a Global Leader in Advanced Technology Applications of Locational Data

It is well understood by market researchers of geospatial development that one path to realizing the future value of geospatial technologies and applications is closely connected to specific industries and their applications of advanced technology applications of locational data or what might be termed "location tech applications." As GeoBuiz explains: "Leveraging on spatial information, various traditional and emerging geospatial applications are ... finding varied use in transportation, construction, mining, agriculture, utilities, and government, among many others, thus generating huge value impact for economies worldwide." [10]

While St. Louis is not a leader in innovations around traditional technologies for geospatial development, such as satellite platforms and remote sensing technologies, the region does have the innovation and talent capacities in advanced computing and data sciences needed for future applications to unlock the value of locational data. The STL GeoFutures Initiative recognizes the importance of the St. Louis region becoming a national leader in location tech applications.

But what does it take to raise the market position of St. Louis in location tech applications? The answer lies in what it takes to grow an industry cluster. The logic of industry clustering as an economic development strategy is that it offers regional economies a way to gain competitive advantage by specializing in inter-related industries and evolving those specializations over time. As Michael Porter, one of our nation's leading experts in business and regional competitiveness, explains:

"Clusters are a striking feature of virtually every national, regional, state and even metropolitan economy, especially in more economically advanced nations... Clusters are not unique, however; they are highly typical—and herein lies a paradox: the enduring competitive advantages in a global economy lie increasingly in local things—knowledge, relationships, motivation—that distant rivals cannot match."[11]

Not all industry clusters are the same. The most traditional view of industry clusters is as tightly-linked product and supply chains often found in manufacturing sectors. But The Brookings Institution in its 2018 report *Rethinking Industry Cluster Initiatives* points out that two other types of "cross-cutting" industry clusters also offer strong interdependency between firms, namely through a region's specialization in occupations and skills as well as its core competencies in specific technologies and know-how.[12]

For St. Louis the focus on location tech applications fits into the cross-cutting type of industry cluster capable of serving a wide range of industries that taps the region's existing occupation and skill base. Over time, it is expected that the the region's advanced computing and data science capabilities can be applied to compete as a technology and know-how cluster.

To assess the growth opportunities for St. Louis to pursue location tech applications, a close examination of leading industry sectors was conducted to identify those that rely heavily on locational data and will need to integrate advanced technologies to unlock the potential for future locational applications. Two critical criteria were applied to identify these growth opportunities in leading industry sectors based in St. Louis for locational tech applications:

1. Key assets found in St. Louis, including existing St. Louis industry strengths, innovation activities, and alignment with university capabilities and centers of excellence; and

2. Market potential and identification of locational technology applications that can provide competitive advantages.

10 *Geospatial Media and Communications, GeoBuiz 2018, page 25*
11 *Michael Porter, Harvard Business School Professor, "Clusters and the New Economics of Competition," Harvard Business Review, November-December 1998.*
12 *Donahue, Parilla and McDearman, Rethinking Cluster Initiatives, The Brookings Institution, July 2018*

FIGURE 16: SUMMARY OF LIKELY GROWTH OPPORTUNITIES ALIGNING LEADING INDUSTRY SECTORS IN ST. LOUIS WITH DEMAND FOR LOCATIONAL TECH APPLICATIONS

Four specific leading industry sectors in St. Louis emerged from applying these criteria demonstrating the potential reach of locational technology applications in St. Louis capable of leveraging the region's leading industry sectors that are closely aligned with the use of locational data and geospatial technologies for their competitive advantage, including:

- National Security
- Digital/Precision Agriculture
- Transportation & Logistics
- Health Care Delivery

On the next page are profiles of each of these potential growth opportunities, highlighting their assets in the region, market potentials and location-based applications and insights from industry discussions including focus group sessions around specific growth opportunities.

Together these four leading industry sectors demonstrate the possibility for St. Louis to differentiate itself based on where a focus on locational tech applications can provide a competitive advantage to growing leading industry sectors based in St. Louis. St. Louis needs to engage with these leading industry sectors to raise an awareness of the value of locational tech applications and build out industry-driven use cases that can drive innovation leading to new products and services as well as startup companies. Still, talent is a deep concern and challenge, particularly to keep pace with modern software development and computing skills that also brings an understanding of geospatial analysis.

NATIONAL SECURITY

HIGHLIGHTS:

- Anchor for regional geospatial activities
- Leading driver of regional geospatial workforce
- Significant technology opportunities involving advanced computing and data sciences

KEY ASSETS:

- NGA stands as a key anchor institution with direct employment of 3,700 jobs in the St. Louis region
- Vast majority of leading companies involved in geospatial activities in St. Louis working in National Security
- Approximately 4,600 of the 6,643—or two-thirds—of private sector geospatial jobs in St. Louis companies working in defense-related activities
- Broader aerospace and defense industry cluster is highly specialized, sizable and growing in St. Louis
- Greater than 2.6x the level of concentration found in the nation
- More than 15,000 jobs in 2017
- 12 percent growth from 2010-2017

MARKET AND APPLICATIONS:

- NGA spends more than $2 billion annually on IT services
- Leading technology requirements of NGA include:
  - Addressing the migration to the cloud with modern approach to software development bringing forward new capabilities in data automation, augmentation and conflation
  - Apply data science capabilities to core analytic products of NGA similar to what is found in AdTech in what might be termed real-time "spatial" decision making
  - Systemize Big Data, computer vision and machine learning to all types of remote sensing data to detect objects at a high level of confidence (95 percent+)

INSIGHTS FROM INDUSTRY FOCUS GROUP DISCUSSION:

- The need for a talent pool with defense security clearances is a major challenge for defense contractors and NGA.
- NGA embraces small company set-asides and so an ecosystem between large DoD contractors and small companies offering niche technology services is present and can continue to grow.
- Still, the DoD innovation and entrepreneurial base not as strong as it needs to be in the region. There is broad agreement on the need for small innovative St. Louis companies to focus on applying for and winning federal Small Business Innovation Research (SBIR) awards in geospatial topics. There is also a need for matchmaking and building relationships between DoD and St. Louis companies.
- Small growth-oriented DoD contractors face a challenge in accessing risk capital – even challenging regarding banking for government contracts.
- Noted the importance of going beyond national security needs for geospatial intelligence activities to more broadly define the value of the region's geospatial ecosystem. Opportunities in logistics, especially given the presence of USTRANSCOM, might be a high-value, dual-use application.

DIGITAL AGRICULTURE/PRECISION AGRICULTURE

HIGHLIGHTS:

- Fast market growth
- Strong customer base involving region's industry specialization in agbiosciences and food manufacturing
- Leverage regional strengths in plant biology and IT
- Industry leaders and research institution strengths found in St. Louis
- Precision ag involving more on-farm technologies to improve yields is becoming a component of a broader digital agriculture focus that spans the entire agriculture value chain to improve food production and sustainability involving a wider range of digital technologies, such as e-commerce, Internet of Things and blockchain tracking.[13]

KEY ASSETS:

- Leading customer base of agbiosciences and food processing
- Direct employment of nearly 27,000 jobs
- Leading industry specialization in agbiosciences, including agricultural seed and chemicals
- Presence of Bayer and Climate Corp provides St. Louis with national leaders in advancing precision agriculture
- Active base of start-up activities
- Pitchbook reports 10 AgTech companies receiving VC funding since 2015
- Presence of Yield Lab and BioGenerator for entrepreneurial support and funding with follow-on investment from Cultivation Capital
- Strength of academic research activities bringing plant sciences and IT together, including: Danforth Center, EPSCoR, Mizzou Department of Agricultural Systems Management, SLU Remote Sensing Lab, etc.

MARKET AND APPLICATIONS:

- Sizable and fast-growing market14
- Nearly $5 billion in 2018 and expected to more than double by 2025
- Sub-markets including yield monitoring, field mapping, crop scouting, weather tracking, irrigation management, etc.
- Comprehensive application of geospatial technologies across:
    - Automation and control systems (i.e. guidance system, drones, driverless tractors, etc.)
    - Remote sensing (i.e. soil, water, climate)
    - Software & Services (i.e. cloud, systems integration, data analysis, decision support)

13 For more on digital agriculture, see Project Breakthrough, Digital Agriculture: Feeding the Future, United Nations Global Compact
14 See Grandview Research, Precision Farming Market, May 2019 and OGAnalysis, Global Precision Agriculture Market by Technology, May 2019.

INSIGHTS FROM INDUSTRY FOCUS GROUP DISCUSSIONS:

- Strong support for having digital/precision agriculture focus within STL GeoFutures Initiative. Few places can rival St. Louis in plant sciences, and digital/precision agriculture is an important growth area.

- Opportunities in digital/precision agriculture should be extended out to consider the broader food supply chain and the importance of sustainability across the supply chain to better manage where food is being sourced, how it is processed and brought to market, or what is commonly being referred to as digital agriculture.

- Innovation and entrepreneurial development in digital/precision agriculture is struggling in St. Louis outside of Bayer/Climate Corp. Entrepreneurial community needs more exposure to the challenges that need solutions in digital/precision agriculture through activities such as a "hack-a-thon" with geospatial developers around a digital/precision agriculture problem set, increased networking among different players in the agriculture/food supply chain and focusing on key topics of "geospatial for sustainable ag/ecosystems" that can drive innovation using technologies like blockchain in agriculture and supply chain.

- From the researcher perspective, the geo-data piece is a missing component in their capacity – e.g. below and above-ground sensors, soil data, traits, etc. need for individual plant tracking/tagging in a field. Industry has this capability in St. Louis but it is not extended to research community. Other regions with leading agricultural schools are able to overcome through use of research farms.

> "Precision agriculture is thought by many to be the biggest technological change in agriculture since the introduction of hydraulics in the 1940's.
>
> The backbone technology used in precision agriculture is GPS-enhanced guidance and mapping capabilities."
>
> Focus Investment Banking, LLC

- A critical workforce and talent challenge in St. Louis is finding geospatial analysts with software development skills, which highlights importance of having "hybrid" geospatial developers.

- Another regional gap is not having a top-tier PhD Geography program in the region. This offers higher end talent able to operate with a broader skill set linking geospatial analysis and "open source" technologies.

TRANSPORTATION & LOGISTICS

HIGHLIGHTS:

- Significant industry base in St. Louis
- Anchor military organization with USTRANSCOM
- Very large markets and deepening utilization of geospatial applications
- Academic programs across institutions in St. Louis

KEY ASSETS:

- Significant base of transportation and logistics services in St. Louis Region
    - Direct employment of nearly 39,000 jobs
    - Strong growth of 17 percent from 2010 to 2017
    - St. Louis is home to Enterprise Holdings, one of the largest commercial logistics organizations in the world and a leader in advancing the use of geospatial technologies and applications
- Presence of USTRANSCOM at Scott Air Force Base
    - Tasked with the coordination of people and transportation assets to allow the U.S. to project and sustain forces, whenever, wherever, and for as long as they are needed across air, land and sea transportation
- Academic programs in transportation and logistics and supply chain found at many universities in the region, including:
    - UM System's newly launched Missouri Center for Transportation Innovation
    - Center for Excellence in Logistics and Distribution at Mizzou, an NSF-funded Industry-University Cooperative Research Center
    - Center for Supply Chain Excellence at SLU School of Business
    - Supply Chain & Analytics Department at UMSL School of Business
    - Mechatronics and Robotics Department at SIUE working on autonomous vehicles

MARKET AND APPLICATIONS:

- Logistics is nearing a $10+ trillion market that continues to record steady growth[15]
    - Expected to grow 7.5 percent on an annual compounded rate through 2023.
- Autonomous car market expected to grow at phenomenal rates of 30 percent+ annually[16]
- Key Applications include:
    - Global positioning systems for navigation
    - In-vehicle tracking
    - Self-driving vehicles
    - Intelligent transportation system
    - Route planning
    - Container tracking

15 *Transparency Market Research, Global Logistics Market*
16 *Allied Market Research, Global Market for Autonomous Vehicles*

INSIGHTS FROM INDUSTRY FOCUS GROUP DISCUSSIONS:

- St. Louis' transportation and logistics sector competes against major hubs in Chicago, Memphis and Nashville. Important to define niches and leverage innovation to compete, especially in concert with anchor companies in the region like Enterprise, Hogan Trucking and large company supply-chain managers.

- St. Louis is behind other regions in Smart Cities applications and use of test beds in transportation and logistics. Opportunity to link a test bed around integrated transportation and logistics tapping St. Louis having port, rail, trucking and air freight. Challenge of coordinating Smart City applications across two states needs to be addressed. Also, lots of data on mixed uses of transportation that can be mined for innovation using advanced analytics that would link public and private sectors.

- Workforce a major challenge and constraint. Emphasis should be on hybrid skills that educate students in modern computer science skills along with an understanding of geospatial analysis.

- Rise of supply chain programs in the region offer a competitive advantage and bring a focus on training and retraining of transportation and logistics specialists. There can be a major advantage for St. Louis region in aligning supply chain and geospatial technologies and analysis into workforce skills.

Precision Logistics Coming of Age

Across both commercial and military sectors, geospatial technologies and applications are giving rise to precision logistics to offer enhanced approaches to managing complex supply chains.

The Army and Marine Corps have introduced a new operational concept of the Multi-Domain Battlespace (MDB) that will require considerable innovations across military supply chains. The dynamic nature of the MDB fight changes the variables of sustainment and drives the need for precision logistics. Precision logistics is the accurate delivery of essential supplies and equipment to the right place at the right time and in the right quantity throughout the contested battlespace (see https://www.army.mil/article/198432/sustainment_innovation_for_multi_domain_battle).

Similarly, in commercial supply chain management precision logistics is coming into wide usage for products involving complex logistics requirements, such as medical supplies that require precise temperature, light exposure and barometric pressures in its handling. The Wall Street Journal reports on the use of precision logistics for delivery of sensitive medical supplies that uses sensors and data analytics to track medical packages exact location in near-real time. UPS calls its new precision logistics service for medical supplies UPS Premier, while FedEx has its own precision logistics service widely used for managing medical logistics supply chains, known as SenseAware (see https://www.wsj.com/articles/ups-to-use-sensors-that-can-track-medical-packages-at-all-times-11574290178?mod=hp_minor_pos4).

HEALTH CARE DELIVERY

HIGHLIGHTS:

- Healthcare is a large and highly specialized industry sector in St. Louis
- Significant activities and opportunities for health innovation found in St. Louis across healthcare systems, public health departments and technology companies
- Geospatial visualization and analysis is proving critical for improving healthcare delivery and health outcomes as demonstrated by use of spatial analysis in helping to guide health responses to the COVID-19 pandemic in St. Louis

KEY ASSETS:

- St. Louis is a national leader in healthcare delivery leading to high levels of industry specialization reflecting clinical excellence
    - More than 120,000 jobs in hospitals, medical labs and specialized health facilities found in St. Louis
    - Most impressively, St. Louis is highly specialized in healthcare pointing to its ability to attract patients beyond local residents with:
        - 2x the national concentration of employment in specialty hospitals (i.e. cancer, children's, heart, etc.)
        - 1.5x the national concentration of employment in general hospitals
    - Barnes-Jewish Hospital is nationally ranked in 10 adult specialties by U.S. News and World Report
- Active startup activities taking place in HealthTech
    - 21 venture-backed startups from 2015 to present

MARKET AND APPLICATIONS:

- The market for geospatial analytics for medical-related applications in North America was estimated to be $2.9 billion in 2019 and projected to grow to $5.8 billion by 2024, a robust 15% compounded annual growth rate.[17]
- A leading application of spatial analysis in medicine is for public health informatics to achieve effective monitoring of health conditions, disease surveillance and enhanced decision-support. In this regard, a key driver is public health-related government agencies, such as Centers for Disease Control and Prevention, National Institutes of Health, Health Resources and Services Administration and Substance Abuse and Mental Health Services Administration.
- Connected health is also expected to be a major driver of medical-related applications of geospatial analytics. Connected health is a component of the Internet of Things where medical devices involving active sensors can be connected to the Internet to allow remote monitoring of medical conditions. Of the nearly 18 billion connected devices worldwide, 22% are estimated to being used for connected health.[18] By 2025, usage of connected devices is expected to roughly double across the globe. Plus, through the use of smart phone applications, increasing monitoring of health conditions is taking place. These sources of health monitoring will have the ability to inform comprehensive medical practice that identifies and could address geospatial determinants of health.
- Another important driver of medical-related geospatial analytics is the growing market for population health management, which seeks to lower healthcare costs while improving the quality of care and health of the population. Population health is transforming the way healthcare is delivered by bringing a focus on addressing the social

17 *BCC Research, Global Geospatial Analytics Market, January 2020*
18 *IBID, page 122*

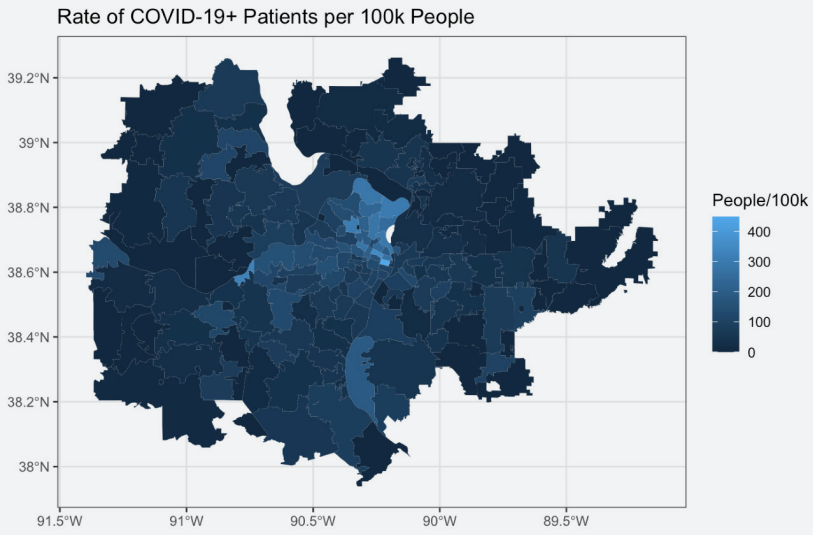
determinants of poor health associated with specific locations since 80% of health outcomes are linked to conditions in the environment in which people are born, live, learn, work, play, and age. Grandview Research projects population health management market to reach $50.3 billion by 2025, a 20.1 percent compounded annual growth rate from 2018 to 2025.[19] Geospatial research partnership with healthcare industries will reveal more of the barriers to positive health behaviors.

INSIGHTS FROM INDUSTRY DISCUSSIONS:

- Many of the healthcare systems and national healthcare companies based in St. Louis are locating innovation and software development groups in the region.

- Community-based activities taking shape to advance innovative approaches that address the determinants of health outcomes and suggest community-led solutions.

- Through the efforts of the St. Louis Metropolitan Pandemic Task Force a new partnership is taking form involving the region's major healthcare systems, health departments and research universities to create a comprehensive health data commons for the region. This group collectively is responding to the needs of the region informed geospatially. This health data commons is essential for enabling geospatial visualization and analysis required for tracking, modeling and targeting healthcare delivery needs to respond to the COVID-19 pandemic. Looking to the future, this new healthcare partnership on establishing a health data commons for the region offers a platform that can be further enhanced to enable broad applications of geospatial health-related applications in the years to come to address significant health disparities and population health needs across the St. Louis region.



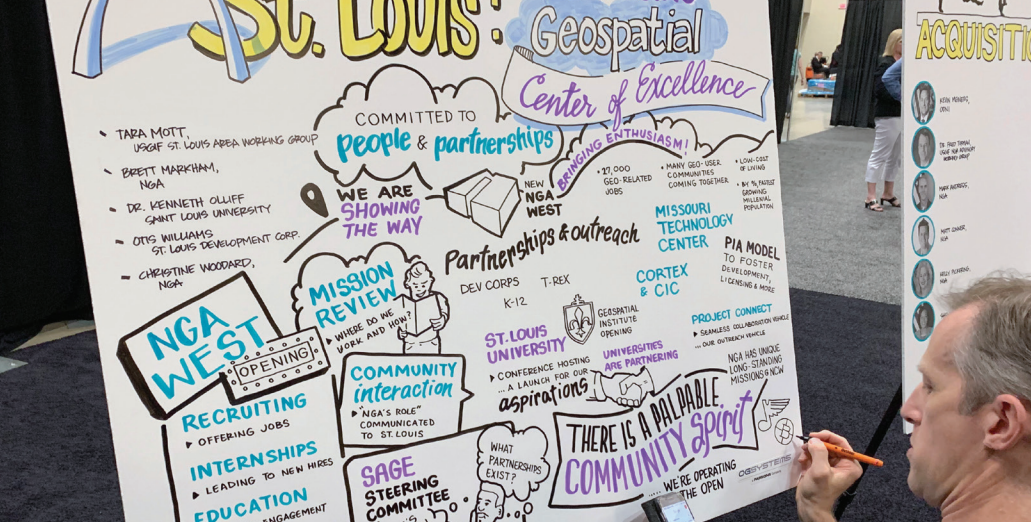
Source: Institute for Informatics, Washington University in St. Louis

Geospatial Sciences Making a Difference in St. Louis Response to COVID-19 Pandemic

At both Saint Louis University and Washington University in St. Louis, data and public health researchers are applying geospatial visualization and analysis to tracking, modeling, and targeting healthcare resources to address the COVID-19 pandemic, including:

- Forming an Epidemiology Strike Force to bring together privacy-protected health data from disparate sources, including healthcare systems across the region, to identify virus hot spots down to the street level, target healthcare resources and improve disease modeling.
- Developing and implementing a smart phone app to monitor real-time symptoms and the location of symptomatic individuals and nearby healthcare facilities
- Using geolocation data to examine the effectiveness of social distancing orders, complementing different sources of data to geospatially link infection and risk, and modeling the infection risk in nursing homes and airports
- Addressing ethical concerns and individuals' perception of privacy in tracking geospatial data

19 *See https://www.grandviewresearch.com/press-release/us-population-health-management-market-analysis*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SHOWING
THE WAY
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NGA
WEST
Partnerships & outreach
MISSION
REVIEW
COMMUNITY
interaction
NGA
WEST
OPENING
RECRUITING
INTERNSHIPS
EDUCATION
SAGE
STEERING
COMMITTEE
MISSOURI
TECHNOLOGY
CENTER
CORTEX
& CIC
PIA MODEL
ST. LOUIS
UNIVERSITY
PROJECT CONNECT
THERE IS A PALPABLE
COMMUNITY spirit
ACQUISITI

THE FUTURE OF GEOSPATIAL IS
STLMADE

JIM
EXHIBITOR
STLMADE

THE FUTURE OF GEOSPATIAL IS
STLMADE
START UP | STAND OUT | STAY

STL
MADE
START UP | STAND OUT | STAY
STAY

START UP
STAND OUT
St. Louis is among Forbes' Top 10 rising cities for start-ups
THE FUTURE OF GEOSPATIAL IS
STLMADE

HARRIS
THE FUTURE OF GEOSPATIAL IS
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GEOFUTURES

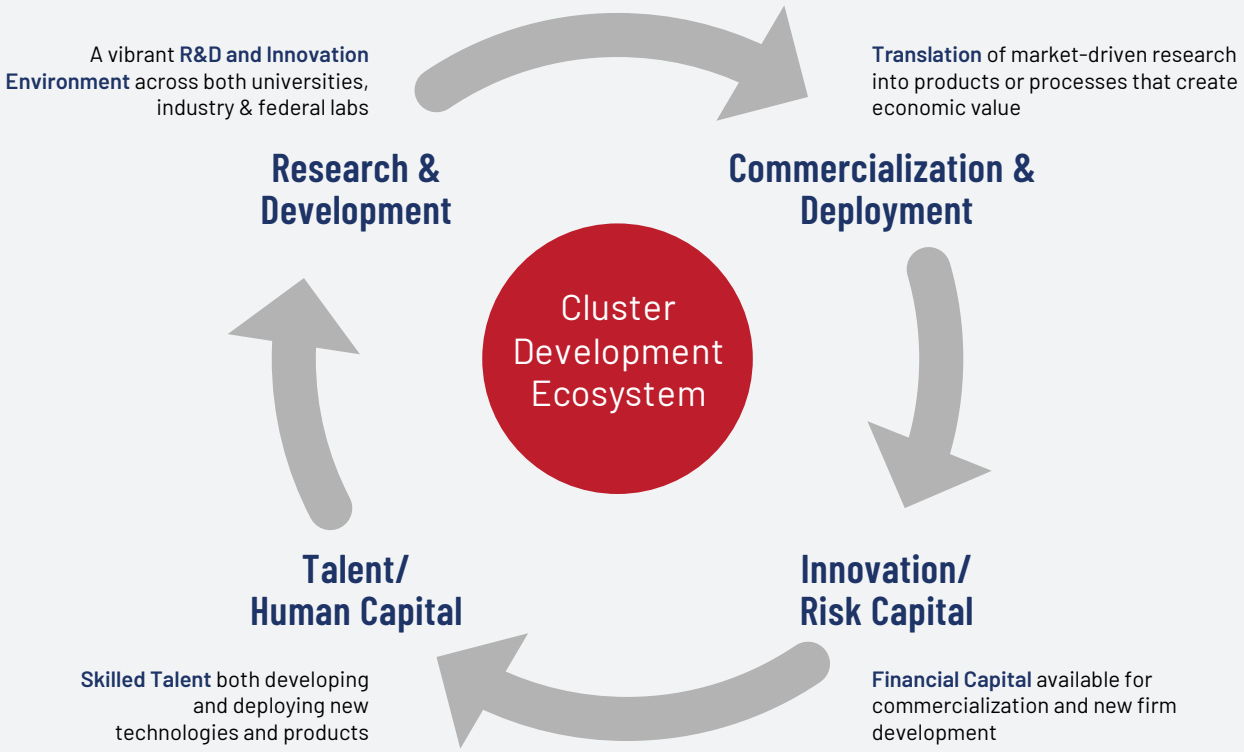
COMPETITIVE POSITION

OF ST. LOUIS IN THE GEOSPATIAL SECTOR

The Competitive Position of St. Louis in the Geospatial Sector

The identification of growth opportunities for St. Louis in geospatial development sets the stage for broader development efforts, but still depends upon an understanding of the competitive position of St. Louis for supporting geospatial development to be successful. For innovation-led development to take place, a broader set of economic foundations is required across a region's research and development capacity, entrepreneurial culture, access to a skilled workforce and high-quality physical infrastructure. Regions that excel provide these enhanced economic foundations in a high-functioning, inter-connected ecosystem and are able to translate research and development capacity through commercialization into new product development for existing firms as well as new firm formation. The quality of these enhanced economic foundations and the connections among organizations in the ecosystem also attract outside business investment and expansion within a region. Figure 17 captures this broader business environment involving enhanced economic foundations in the context of a high-functioning ecosystem in which innovation-led development thrives.

FIGURE 17: A WELL-FUNCTIONING ECOSYSTEM IS REQUIRED FOR A TECH-BASED INDUSTRY CLUSTER TO THRIVE



Source: TEConomy Partners, LLC.

Benchmarking Critical Ecosystem Elements for a Thriving Tech-Based Industry Cluster

St. Louis' competitive position and performance in a burgeoning geospatial cluster can be better understood by comparisons against its competition—specifically, other leading regions in the research, development and applications of location-driven technologies. Five benchmark regions were selected for comparisons against the St. Louis metro region, representing a blend of leading technology hubs with concentrations and key investments in geospatial tech, as well as at least one emerging region:

1. **Greater Denver:** the region from Denver north to Fort Collins represents a major hub for university R&D in geospatial fields including remote and other imaging analysis; and a strong concentration in aerospace and related industry.

2. **Greater Los Angeles:** the region stands out in geospatial industry and innovation activity and includes the headquarters of Esri and a major aerospace industry presence with a sizable geospatial workforce.

3. **Philadelphia:** emerging in industrial geospatial development with rapidly growing risk capital funding.

4. **Silicon Valley:** the nation's leading tech innovation hub, including a very large presence of geospatial companies and innovation.

5. **Washington, D.C.:** the leading region in the national security and defense-related geospatial applications and tech development complex.

The quantitative benchmarking analysis utilizes key metrics, normalized by population and size of the regional economy to account for regional size differences, across four key components of the innovation ecosystem.

The Value of Regional Benchmarking for a Strategic Roadmap

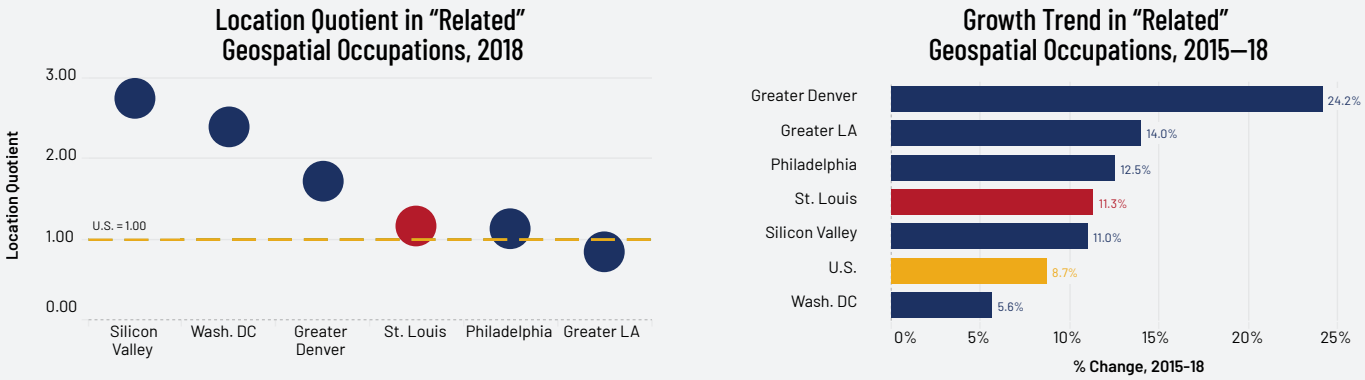
- Learning where the region stands across key components of the ecosystem and how it has evolved over time;
- Identifying the competition, analyzing how other regions are doing by comparison; and
- Isolating strategic issues, understanding where across the ecosystem the region has comparative strengths to leverage and/or weaknesses to address.

GEOSPATIAL WORKFORCE AND TALENT: A COMPETITIVE STRENGTH FOR ST. LOUIS

St. Louis stands out in the size, concentration, and growth of its geospatial and broader tech workforce compared with the nation and other regions. The region employs nearly 53,000 workers in geospatial-related occupations, with the bulk of these workers in key areas in IT, data sciences, and electrical engineering. In these critical "related" job and skill areas, the region is 15 percent more concentrated relative to the national average and has grown at a double-digit pace, outpacing national growth since 2015 (Figure 18). This strong demand is further evident in analysis of regional job openings where more than 7,000 unique job postings requiring geospatial-specific hard skills were identified during the latest 3-year period. St. Louis also stands out in its demand for geospatial talent relative to all job postings.

While St. Louis has strong concentrations of geospatial-related tech talent relative to its size, both established and emerging U.S. tech hubs are far from standing still. Even with tech employment bases that are two to four times larger than St. Louis', regions such as Greater Denver, Greater Los Angeles, and Philadelphia still have outpaced St. Louis' growth in geospatial-related occupational employment.

FIGURE 18: REGIONAL CONCENTRATION AND GROWTH TRENDS FOR GEOSPATIAL-RELATED IT, DATA SCIENCES, ENGINEERING OCCUPATIONS



Note: Occupational areas were informed by a National Research Council report, Future U.S. Workforce for Geospatial Intelligence, 2013. A location quotient (LQ) measures the concentration of an industry or occupation within a region's overall employment relative to the national average. Therefore, a LQ greater than 1.0 signifies a greater than average regional concentration or specialization.

Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, Occupational Employment Statistics data.

UNIVERSITY EDUCATION AND RESEARCH: A MIXED PERFORMANCE FOR ST. LOUIS

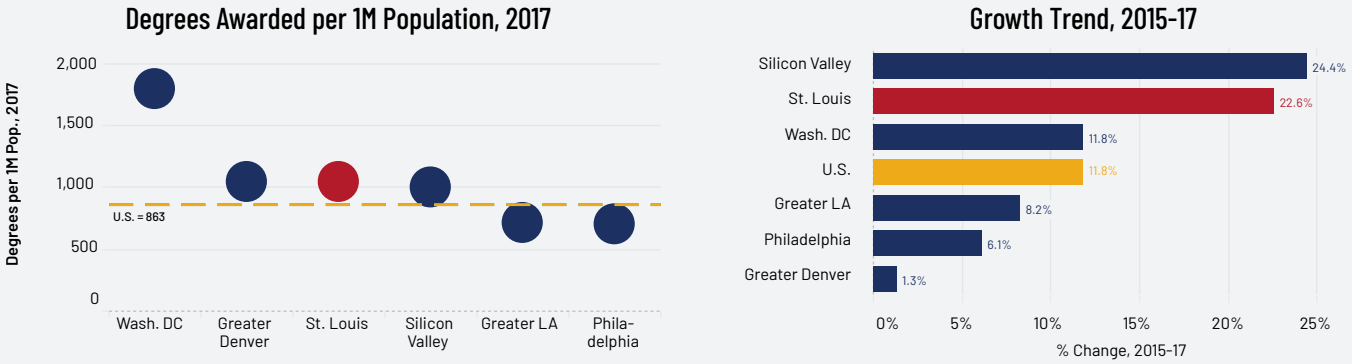
St. Louis' numerous colleges and universities represent a major asset for advancing both geospatial-related education and research.[20] Regional universities are graduating sizable, highly concentrated, and growing numbers in fields most closely related to geospatial technology and workforce needs, making education a clear strength of the ecosystem. The region graduated nearly 3,000 in 2017 in geospatial-related fields across all postsecondary levels from certificates and associate's up through doctorates.[21] St. Louis exceeds the national average in conferring these degrees on a per capita basis (Figure 19). Regional institutions are growing their graduate totals rapidly relative to both the U.S. and comparison regions. St. Louis has grown its degree base by 22.6 percent since 2015, compared with 11.8 percent nationally. The region stands out relative to the nation in graduate shares in both math and statistics, and in geospatial-related engineering fields (aerospace, engineering physics, operations research, geological/geophysical).

St. Louis still faces stiff competition from other regions. In geospatial-related degrees, Washington, DC has a significantly greater concentration of degree graduates per capita, standing out in its very high concentration of graduates in computer and information sciences. Meanwhile, Silicon Valley institutions have narrowly outpaced St. Louis in degree growth since 2015.

20 *Analysis includes colleges and universities that serve the St. Louis metro region and includes several located outside of the region:"the University of Missouri-Columbia; Missouri University of Science and Technology; and the University of Illinois-Urbana-Champaign.*

21 *Geospatial-related degree fields are those identified by the National Research Council (NRC) in Future U.S. Workforce for Geospatial Intelligence, 2013. TEConomy has supplemented the NRC list to include Computer Sciences and Data Sciences more completely.*

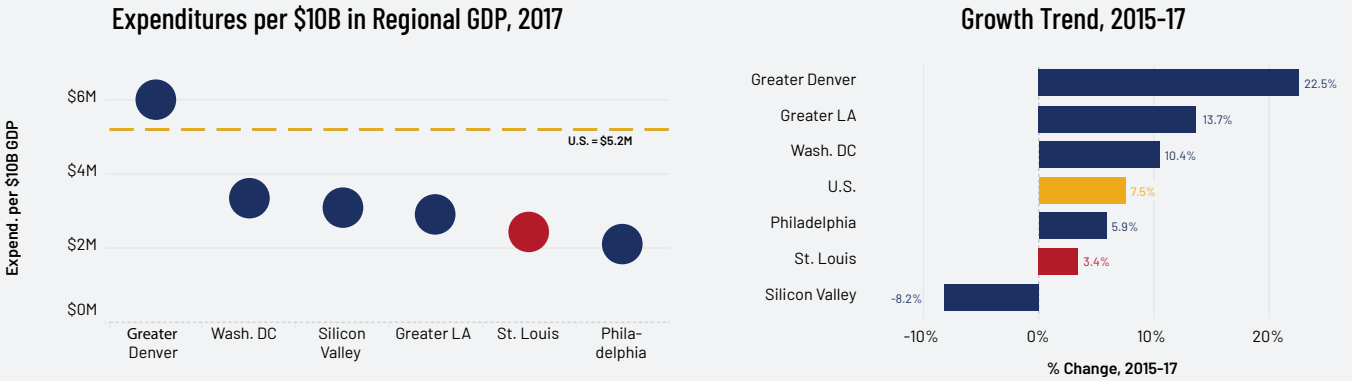
FIGURE 19: POSTSECONDARY DEGREE GRADUATES IN GEOSPATIAL-RELATED FIELDS, REGIONAL CONCENTRATION AND RECENT GROWTH



Source: TEConomy Partners' analysis of National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS). Data include all degree and certificate levels. Geospatial-related degree fields are those identified by the National Research Council in Future U.S. Workforce for Geospatial Intelligence, 2013. TEConomy has supplemented to include Computer Sciences and Data Sciences more completely.

The St. Louis region, with $38.8M in geospatial-related R&D expenditures in 2017, lags behind the national average and most comparison regions in both its activity relative to the size of its economy but also with respect to recent growth (Figure 20). Greater Denver, with $355 million in R&D expenditures, leads among the benchmarks in its concentration and growth of activity, with focused specializations in geo- and atmospheric sciences, and in aerospace engineering.

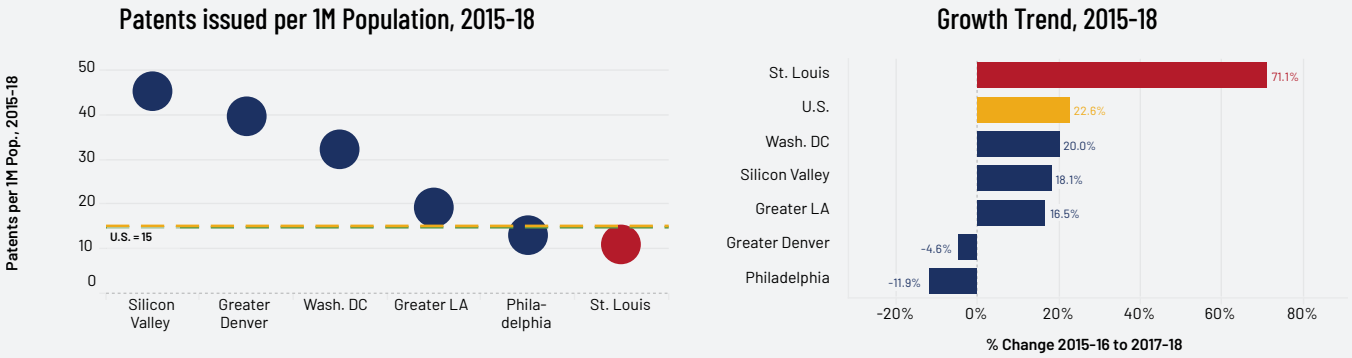
FIGURE 20: UNIVERSITY R&D EXPENDITURES IN GEOSPATIAL-RELATED FIELDS, REGIONAL CONCENTRATION AND GROWTH TRENDS



Note: Includes the following as Geospatial-related academic fields: Aerospace/Aeronautical/Astronautical Engineering; Geosciences, Atmospheric Sciences, and Ocean Sciences; Electrical//Electronic/Communications Engineering; Computer and Information Sciences.

Source: TEConomy Partners' analysis of National Science Foundation, Higher Education Research and Development Survey.

FIGURE 21: GEOSPATIAL-RELATED PATENTS ISSUED, REGIONAL CONCENTRATION AND GROWTH TRENDS



Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

TECHNOLOGY DEVELOPMENT: AN AREA FOR IMPROVEMENT FOR ST. LOUIS

St. Louis is lagging behind the U.S. and comparison regions in geospatial-related patent activity, a key indicator of tech innovation. The St. Louis region, with 122 total patents awarded in geospatial technology areas from 2015-18, is just below the national average relative to its population and lagging the comparison regions (Figure 21). The region has grown its patent activity, though from a modest base level. Relative to their populations, the Washington, DC and Greater Denver regions are patenting at rates three to four times that of St. Louis, and Silicon Valley reaches about 20 times more. Examples of geospatial-related patent classes include radar sensors and systems; wireless location ID; vehicular navigation systems/guidance; autonomous aircraft systems; global positioning systems; and data analytics methods, among others.

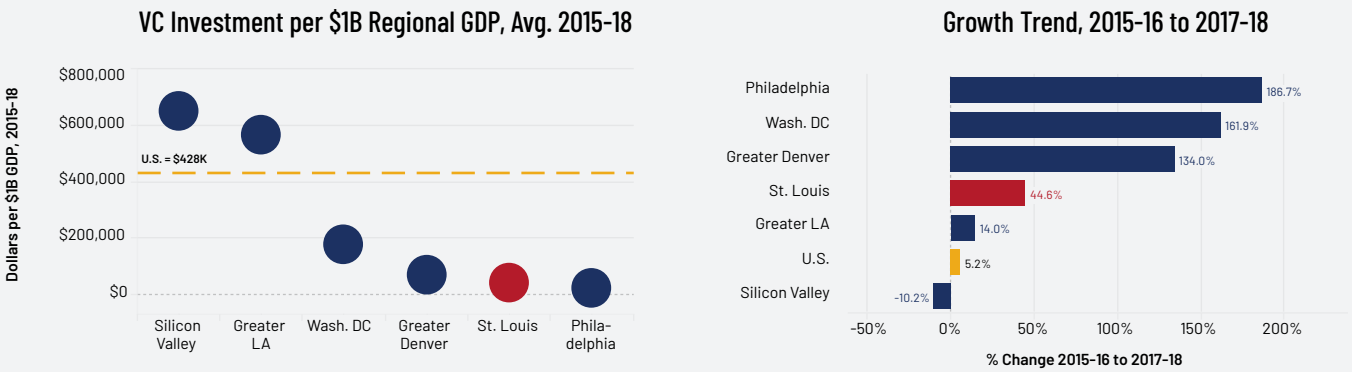
Similarly, St. Louis is underperforming in accessing federal SBIR and STTR grants for tech development among small, innovative companies. The region's geospatial companies received no awards during the 2015-18 period, while comparison regions overall averaged 56 awards per year and have ranged from 125 in Philadelphia to 843 in Greater Los Angeles during the 4-year period.

RISK CAPITAL: AN AREA FOR IMPROVEMENT FOR ST. LOUIS

St. Louis' geospatial companies have received modest venture capital (VC) investments in recent years—lagging comparison regions in both deal activity and investment levels—though regional investment has been on an upward trend. The region saw 14 total VC deals from 2015-19, translating to an average per year deal flow that is last among the benchmark regions. The $28.9 million invested in St. Louis companies during this period lags well behind the U.S. and most other comparison regions relative to the size of its economy. The region's investment totals have increased in recent years (up nearly 45 percent), however, outpacing national growth (5 percent).

While St. Louis has seen gains in VC investments, competitor regions have large capital investment bases in geospatial companies and are growing rapidly—Philadelphia ($72 million); Washington, DC ($511 million); and Greater Denver ($99 million), have all grown their VC totals by more than 100 percent from 2015-16 to 2017-18 (Figure 22).

FIGURE 22: VC INVESTMENTS IN GEOSPATIAL COMPANIES, REGIONAL CONCENTRATION AND GROWTH TREND



Source: TEConomy Partners' analysis of PitchBook Venture Capital data.

St. Louis is competing against several large and leading U.S. technology hubs in geospatial sector development. And while regions such as Silicon Valley are clearly ahead in their geospatial and broader tech sectors, no region has planted the geospatial flag and implemented a focused cluster strategy for leadership.

With established and growing strengths in geospatial talent and university education, and an emerging and focused geospatial innovation ecosystem taking root, the region has an opportunity to lead. Taken together, the current "mixed" position of St. Louis' is summarized below (Figure 23)..

FIGURE 23: SUMMARY COMPETITIVE POSITION OF ST. LOUIS IN KEY ECOSYSTEM ELEMENTS

Geospatial Workforce: Regional Strength

Strengths:
- Job Openings: strong demand
- Occupations: above-avg. concentrations, growth in key "related" areas in IT, Data Sciences, Engineering

University Education & Research: Mixed Performance

Strengths:
- Degree Graduates: Strong concentration, recent growth

Weaknesses:
- Lagging behind U.S. and other regions in academic R&D activity and growth

Tech Development: Area for Improvement

Strengths:
- Patents: Growth in patents issued though from a modest base level

Weaknesses:
- Patent activity lags U.S., other regions
- Zero geospatial SBIR awards identified

Risk Capital: Area for Improvement

Strengths:
- Modest VC investment levels have increased in recent years

Weaknesses:
- VC deal and investment levels lag comparison regions

Source: TEConomy Partners' analysis.

GEOFUTURES

SETTING STL GEOFUTURES
STRATEGIC ROADMAP

Setting a Strategic Roadmap for the STL GeoFutures Initiative

The assessment of future opportunities and competitive position of the St. Louis region in geospatial development served as a starting point for engaging a broad range of St. Louis stakeholders in helping to shape a fuller situational assessment and strategic direction for the STL GeoFutures Initiative. This effort involved five meetings of the STL GeoFutures Initiative Advisory Committee, the input of 95 companies and organizations involved in geospatial-development and broader economic development of the region, as well as the input from six focus group meetings involving 80 participants.

The culmination of this extensive and deliberate process of analysis, outreach and discussions is a Strategic Roadmap to provide the framework for the St. Louis region to realize its potential in geospatial development. The key elements of this Strategic Roadmap set out below include:

- A shared vision of success to serve as the mission statement for the STL GeoFutures Initiative with near-term and longer-term objectives on how to reach this vision
- A game plan of specific strategic priorities and actions that is comprehensive and tailored to the specific situational assessment found in the St. Louis region of opportunities to be realized and areas of improvement that need to be addressed, in concert with ongoing activities and existing resources as well as informed by best practices in innovation cluster development
- An implementation plan that measures up in its governance, organizational approach and activities to build upon the STL GeoFutures Initiative process and offer a catalytic and sustainable means to steer, invest, convene, and engage for future success

Vision for STL GeoFutures Initiative

Build upon the St. Louis region's substantial assets and deep connections to geospatial development for national security to further transformative, equitable and inclusive growth as a global center of excellence for advanced technology applications of locational data in leading industry sectors and community services.

Strategic Vision and Objectives

The vision that emerged for the STL GeoFutures Initiative is **BOLD** in its ambition and focus:

Underpinning this vision are two key observations that the stakeholders strongly embraced:

- The STL GeoFutures Initiative is ideally situated to be a driver for equitable and inclusive regional growth not only by offering a means to engage disinvested people and places, particularly communities of color, in employment, ownership and broader community wealth building[22], but by improving the fundamental preconditions shaping the ability of people and places to participate in economic growth using the technologies and tools of geospatial development to address population health, transportation access, and crime and safety, among other socioeconomic challenges, through

22 *Bruce Katz, Ross Baird and Daniel Palmer in their white paper "Towards a New System of Community Wealth" issued on October 27, 2019 by Drexel University Nowak Metro Finance Lab with BluePrint Local and Accelerator for America define community wealth as "a broad-based effort to build equity for low-income residents of disadvantaged communities with the aims to: 1) Grow the individual incomes and assets of neighborhood residents by equipping them with marketable skills and enabling full or partial ownership of homes, commercial properties and businesses; 2) Grow the collective assets of neighborhood residents by endowing locally-run organizations with the ability to create, capture and deploy value for local priorities and purposes; 3) Improve the access to private capital that has high standards, fair terms, a long-term commitment to the neighborhood and reasonable expectations around returns and impact; and 4) Enhance inclusion by bringing fairness and transparency to neighborhood revitalization so that community voices are heard and respected and trust is restored, and local residents have the opportunity to participate in wealth that is created." See https://drexel.edu/nowak-lab/publications/reports/community-wealth/ for more details.*

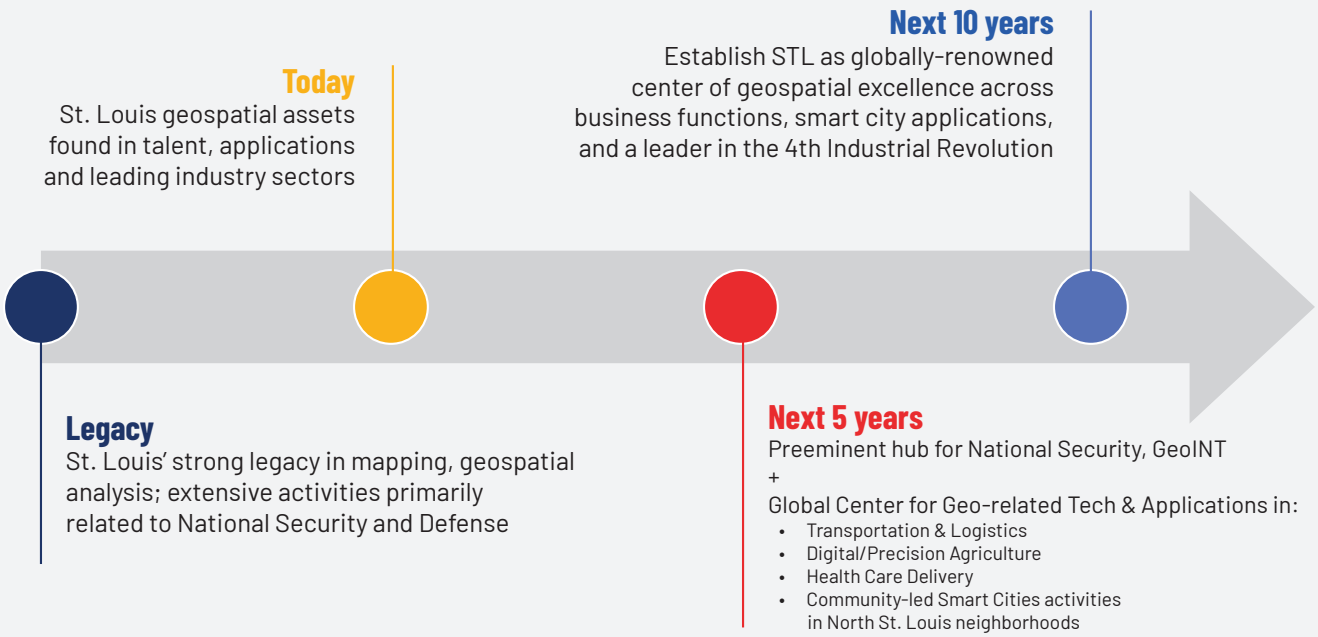
inclusive, community-led Smart Cities initiatives. The unprecedented $1.7 billion investment by NGA in one of the most distressed and underinvested communities of St. Louis is a significant starting point for targeting equitable and inclusive growth, and this focus is found within all aspects of the STL GeoFutures Initiative Roadmap.

- The STL GeoFutures Initiative offers a distinctive competitive advantage for St. Louis to fully participate and take a leadership role in the Fourth Industrial Revolution, involving the merging of digital and physical worlds, by leveraging the cutting-edge technologies used in location-based data and applications, such as remote imaging and sensing, smart devices in cyber-physical systems, autonomous systems and Big Data predictive analytics powered by artificial intelligence and machine learning

By building upon St. Louis' current assets and competitive advantages, this vision is also **REALISTIC**. The pathway to success for St. Louis recognizes the region's competitive advantage is the ability of its talent base to adopt and integrate the latest advances in computing and data sciences into geospatial applications that enhance the value of locational data for decision-making and situational awareness to ensure our nation's security, grow businesses and address community needs.

The specific near-term objectives of the STL GeoFutures Initiative are to focus St. Louis geospatial development efforts on where it can be a global leader in geospatial applications based on its leading industries and community priorities. Over the next five years, St. Louis needs to consolidate its position and become the preeminent hub for national security applications of geospatial intelligence, while also building upon its base of industry strengths in areas such transportation and logistics, digital/precision agriculture and healthcare delivery to leverage its broader computing and data sciences technology strengths for advanced locational applications. This requires a broad engagement across industries and communities in St. Louis on the value of locational data and market-driven innovations involving location tech applications, complemented by a focus on inclusive and equitable growth in talent

FIGURE 24: DEPICTION OF DEVELOPMENT ROADMAP FOR THE STL GEOFUTURES INITIATIVE INVOLVING NEAR-TERM AND LONGER-TERM OBJECTIVES



pipelines, workforce development, and entrepreneurial business development.

In the longer term, through the nexus of industry-university-government-community engagement around locational tech applications, St. Louis will stand out as a global thought leader and have a strong standing across artificial intelligence/machine learning, cyber-physical systems/IoT, and autonomy, among other critical technologies. This will raise the region's overall capacities and assets to fully participate as a leading hub in the Fourth Industrial Revolution.

OVERVIEW OF STRATEGIC PRIORITIES AND APPROACHES FOR INVESTMENT TO ENHANCE STL GEOFUTURES INITIATIVE

The vision and objectives for the STL GeoFutures Initiative identified opportunities and strengths to build upon as well as gaps to address in the capacities of the St. Louis region to compete for geospatial development as a global center for advanced technology applications for locational data.

The specific strategic priorities that need to be addressed include:

- Scale Up Talent and Workforce Development to Meet Geospatial Industry Demand
- Raise Innovation Capacity for Advanced Geospatial Technology Applications for Leading Industry and Community Development Drivers
- Accelerate Entrepreneurship and Availability of Risk Capital
- Support the Advancement of Community-led Neighborhood Development in North St. Louis
- Brand and Position St. Louis as a Global Thought Leader in Geospatial-Related Development

The following sections layout the situational assessment involving each of these strategic priorities, where activities in St. Louis stand today to address the needs and recommendations for future actions.

The recommendations call for three signature initiatives, namely:

- **STL GeoFutures Coalition:** Serve as a catalytic steering, investing, convening and leadership development organization to oversee the Roadmap implementation and ensure a sustained commitment to racial equity and inclusive growth across all Roadmap activities
- **STL GeoFutures Talent Initiative:** Support and deepen ongoing K-16 and adult workforce geospatial-related technical education provider efforts, with a particular focus on under-represented communities, particularly Black communities.
- **STL GeoFutures Innovation Collaborative:** Address the opportunity and challenge to "establish STL as a leader in advanced technology applications of locational data" that can drive national security, commercial and community innovation, commercialization and entrepreneurship

Plus, there are a number of collaborative program activities that need to be advanced with the broader St. Louis community to address specific opportunities and gaps, including:

- Establishing an entrepreneurship program for Black tech professionals, with an emphasis on locational tech applications
- Supporting community-led neighborhood development efforts in North St. Louis where the new NGA West headquarters is to be located
- Creating an affiliated matching fund for geospatial venture investments

Strategic Priority A: Scaling Up Talent and Workforce Development to Meet Geospatial Industry Demand

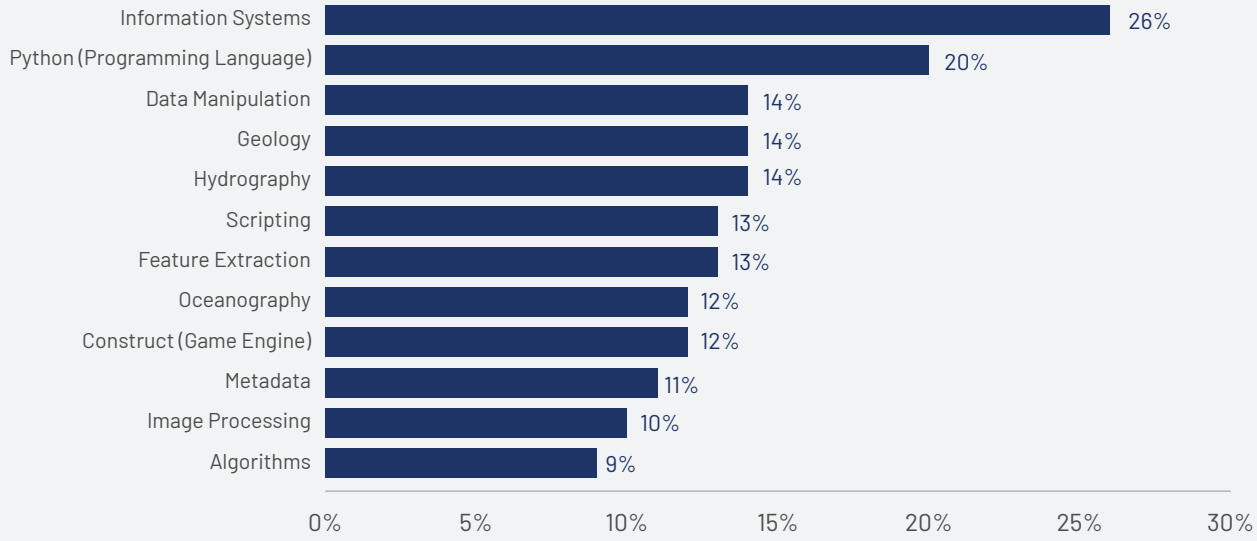
STRATEGIC NEED FOR ST. LOUIS

The region's current competitive advantage in geospatial development is its ability to educate, develop, and deploy a technical talent base with expertise in geospatial and related science and technology applications. The benchmarking and deeper regional assessments have confirmed this talent advantage, with the region actively mobilizing around a breadth of new and expanded programming to maintain this competitive edge. The opportunity for St. Louis is to make this an overwhelming competitive advantage that is able to keep pace with advances in computing and data sciences and broaden its engagement with disinvested regional communities and individuals significantly underrepresented in the current geospatial ecosystem. Despite this position of strength, however, the region has not fully "solved" its geospatial talent situation and reaching this ambitious goal requires continuous attention and implementing strategic approaches to address the talent-related challenges set out here.

Extensive discussions with employers and analyses of St. Louis' geospatial-specific job postings reinforce the primary demand in the geospatial sector for highly skilled talent, almost exclusively hired today at the bachelor's and higher degree levels, with technical skill requirements in areas such as software development and data sciences (see Figure 25). While geospatial job titles can still be found for "traditional" areas such as Geospatial or GIS or Imagery Analyst or Cartographer, today's high-demand titles reflected in job postings requiring geospatial skills include Systems Engineer, Software Engineer, Chief Technology Officer, Data Scientist, Data Engineer, and Business Analyst, just to name some. The expanding applications of location-based technologies and data to guide strategic and business decision-making that are taking hold across both the public and private sectors are being reflected in the evolving demand for talent.

Shifting geospatial job titles and skills requirements reflect the broader challenges and backdrop for today's

FIGURE 25: LEADING TECHNICAL SKILLS IN ST. LOUIS REGIONAL GEOSPATIAL JOB POSTINGS REVEAL EMPHASIS ON IT, ENGINEERING, DATA SCIENCES



Note: The percentages across skill sets in demand sum to greater than 100 percent since jobs can have multiple skill requirements.
Source: TEConomy analysis of EMSI Job Posting Analytics database, 2018.4.

tech workforce—rapidly evolving skill demands and the need for multi-faceted and "hybrid" technical skill sets.

St. Louis' geospatial industry base is consistently voicing a regional talent gap in the need for hybrid skills, specifically for software developers and coders with experience and understanding of spatial applications; database administrators with experience structuring and maintaining spatial data, including massive volumes of remote imagery; and Cloud computing skills and the ability to migrate spatial data and analysis to the Cloud. This is reinforced in NGA's current focus in implementing its "AAA" strategy to leverage AI, Automation, and Augmentation, and the subsequent focus on talent with foundational geospatial skills (e.g. knowledge of geodesy, earth sciences, etc.) with advanced data analysis skills. Industry and NGA have made it clear that the "spatial" in geospatial tech skills, capabilities, and experiences matters, and therefore both university educational and workforce development programs must incorporate and embed within their computer and data sciences programs specific geospatial courses and applications as well as examples, use cases, and even "capstone" projects in geospatial applications using spatial data sets.

Regional employers in the national security segment of the geospatial sector face unique workforce dynamics and challenges, with the most common concern or challenge being their ability to find and hire individuals with security clearances. With a limited talent supply of cleared individuals, St. Louis defense contractors and NGA are "poaching" talent from one another. This challenge is exacerbated for smaller businesses who have limited resources to invest in clearances, especially if they stand to lose talent once clearance is issued. In addition, employers are finding that younger individuals are often not as interested in the national security and defense mission of these organizations compared with prior generations, causing a significant recruiting challenge. There is a need to intentionally develop and grow this regional base of cleared talent, particularly in competition with Washington, DC in the national security talent space.

St. Louis' competition in geospatial talent is fierce, not only from competitor regions, but also in the demand for these professionals by other industries. The benchmarking analysis finds that while St. Louis has strong concentrations of geospatial-related tech talent relative to its size, both established and emerging U.S. tech hubs are far from standing still. Even with tech employment bases that are two to four times larger than St. Louis', regions such as Greater Denver, Greater Los Angeles, and Philadelphia have outpaced St. Louis' growth in geospatial "related" occupational employment in areas including IT, data sciences, and electrical engineering. St. Louis employers often find it hard to match salaries to retain top talent against coastal competitors, as well as difficult in general to recruit into the region from elsewhere. And even within the St. Louis metro region other industries see geospatial tech graduates and employees as highly valued STEM talent with skills to meet their industry needs and challenges as well.

Against this backdrop of strong demand and recognized gaps for geospatial tech talent, the St. Louis region has a largely untapped talent resource in its Black and disinvested communities which must be leveraged. Demographic analysis of the geospatial education pipeline and workforce in the St. Louis region finds that in particular, African-Americans are significantly underrepresented in both geospatial degree programs—where they represent just 6 percent of graduates compared with 8 percent nationally, and well below their 17 percent of the regional population; and in geospatial occupations, where they represent just 9 percent of the workforce compared to 16 percent of overall regional employment. Some progress is being made on the university education front where the level of African-Americans with geospatial-related degrees has increased in recent years and outpaced the nation, though there is clearly a wide gap still to fill. Native St. Louisans meet the U.S. citizenship requirements for security clearances and engaging the regional African-American community in this industry represent a major opportunity to expand our talent base.

The region needs to double-down on talent and workforce development as a competitive advantage, with stronger engagement of its under-represented communities and a focus on keeping pace with rising skill requirements. Many good activities are being advanced and rooted across the region that require resources and the capacity to scale up.

ONGOING REGIONAL ACTIVITIES

With the announcement of, and subsequent excitement surrounding NGA's catalytic investment in St. Louis, the region has mobilized around establishing geospatial career and technology awareness for students as well as growing broader workforce and talent development initiatives and university degree programs. At the region's colleges and universities are numerous education and training programs in geospatial and related technology fields (see Table 4), with graduate totals at nearly 3,000 annually and strong recent growth in degree graduates at nearly twice the pace of the nation.

A number of non-university education and workforce training programs have sprouted up to introduce K-12 students and teachers to geospatial and related "STEAM"[23] technologies and concepts, raise geospatial career awareness, connect students with regional employers, and provide credentialing (see Figure 26). At the same time, a well-established large-scale organization such as LaunchCode is playing a key role in skill development for St. Louis residents aiming to transition into a career in IT, while also engaging in a strategic partnership with NGA to train and upskill its incumbent IT workforce. St. Louis' place-based innovation developments—Cortex and T-REX/Geosaurus and their partners—are also advancing workforce and talent development activities.

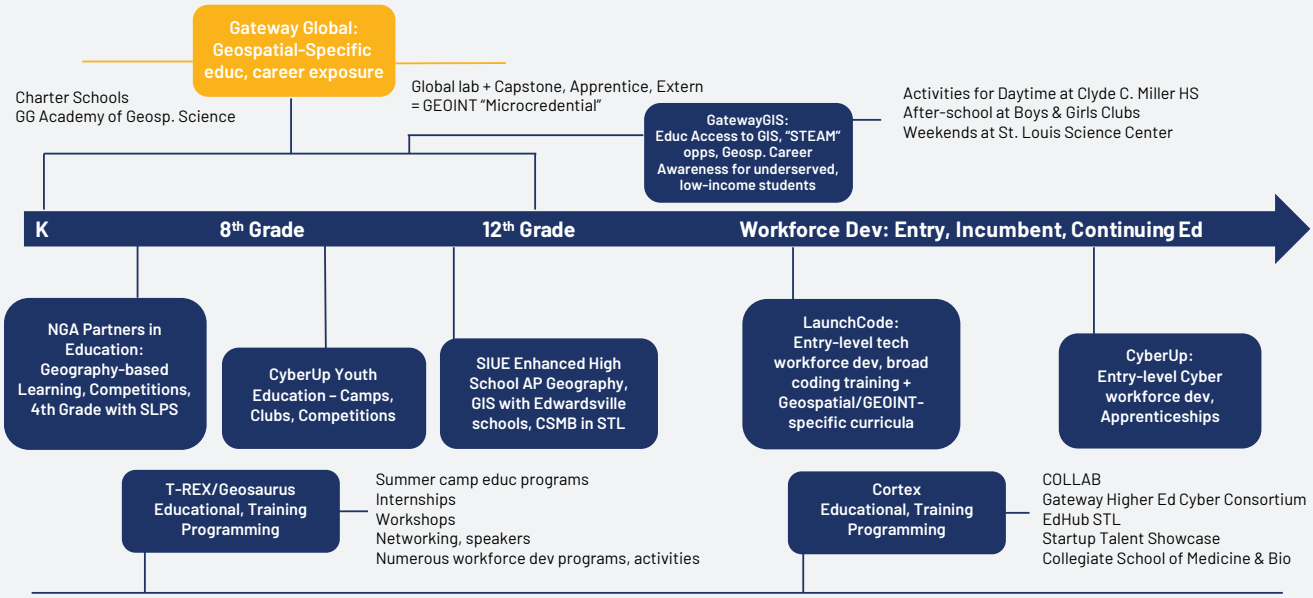
TABLE 4: ST. LOUIS AND BROADER REGIONAL UNIVERSITY DEGREE AND CERTIFICATE PROGRAMS IN GEOSPATIAL-RELATED FIELDS

Technology Field:	University Degree and Certificate Programs
Geo-Information Systems	• Mizzou: BA, MA in Geography; Certificates in GIS, Geospatial Intelligence • MUS&T: Graduate Certificate, Geoanalytics and GeoIntelligence • SIUE: BA, MA in Geography; • SLU: PhD, Integrated and Applied Sciences, Concentration in Geoinformatics and Geospatial Analytics; PhD, Public and Social Policy, Concentration in Policy and Geospatial Analysis; MS, Geographic Information Science; BA, Computational Geospatial Science minor; Certificates, GIS at Graduate and Undergrad levels • WashU: Graduate Certificate, GIS • Webster: Graduate Certificate, GIS (offered in Colorado Springs and Peterson AFB campuses)
Geophysical/ Remote Imaging	• MUS&T: MA, Geotechnics; Graduate Certificate in Geophysics, Geological Hazards (with remote sensing) • SLU: MA, PhD in Geoscience associated with Remote Sensing Lab • WashU: PhD, Imaging Science • Webster: Certificate in Remote Sensing Analysis (offered in Colorado Springs and Peterson AFB campuses)
Cybersecurity	• Harris Stowe: Pending MBA and Certificate, Cybersecurity Management • Maryville: MA and BS, Cybersecurity with Cyber Fusion Center • Mizzou: Undergraduate Certificate • MUS&T: Graduate Certificate with NSA/DHS National Center of Academic Excellence in Cyber Defense • SLU: Masters, Post-Baccalaureate Certificate • SLCC: AAS, Certificate with NSA/DHS National Center of Academic Excellence in Cyber Defense Education 2-year • UMSL: MS, BS, Certificates with NSA/DHS National Center of Academic Excellence in Cyber Defense Education • WashU: Masters, Cybersecurity Engineering; Master's of Cybersecurity Management; Graduate Certificate, Cybersecurity Management • Webster: Masters, Graduate Certificate, C/S concentration
Machine Learning & Data Analytics	• Maryville: MS, BA Data Science with a minor in Business Administratoi • Mizzou:Masters and Graduate Certificate in Data Science & Analytics, with Geospatial Emphasis • MUS&T: Graduate Certificate, Business Analytics and Data Sciences • SIUE: MBA, Business Analytics; Specialization in Business Analytics for MS in Computer Management & Information Systems and Accounting • SLU: Bachelors, Data Science • UMSL: Pending BA in Data Science and Certificates in AI and Data Sciences • WashU: MS, Business Analytics;Graduate Certificate in Data Mining & Machine Learning • Webster: MS and BS, Analytics
Transportation & Logistics	• Mizzou: Graduate and Undergraduate Certificate in Global Logistics • UMSL: PhD, Business with specialization in logistic and supply chain management; Graduate Certificate; BS, Business with specialization in supply chain • SLU: MS, Supply Chain Management; Post-Baccalaureate, Supply Chain Management • WashU: MS, Supply Chain Management

Source: TEConomy Partners inventory.

23 Note: STEAM stands for science, technology, engineering, arts and mathematics

FIGURE 26: REGIONAL STEAM, GEOSPATIAL-RELATED EDUCATION, TRAINING INITIATIVES ACROSS THE TALENT PIPELINE (NON-UNIVERSITY)



Note: Yellow shading means program is in planning phases, not yet fully operational.

PROGRAMMATIC ACTIVITIES & ACTIONS NEEDED:

To address the identified gaps and challenges described herein and to seize opportunities to enhance the impact and scale of the existing programs and initiatives underway there should be an emphasis on the following activities. Many of these recommended activities reflect the input and ideas of regional stakeholders engaged in project interviews, site visits, and focus groups.

- **Support and deepen ongoing K-12 geospatial education and career awareness efforts, with a particular focus on under-represented communities.**
  - Train K-12 teachers in core geographic, geo-analysis, GIS, and other areas to expand classroom learning opportunities and connections to the regional sector, with an intentional, primary focus on teachers and schools in disinvested communities and neighborhoods.
  - Enlist industry guidance regarding skill needs and requirements, leveraging geospatial industry networks such as the St. Louis Area Working Group affiliated with USGIF.
  - Hold industry-led geospatial career seminars for regional guidance/career counselors, particularly at the middle and high school levels in disinvested communities and neighborhoods to inform them of career opportunities, postsecondary degree requirements for geospatial-related degree and career tracks, and local opportunities for school engagement.
  - Coordinate regional K-12 geospatial educational activities with Missouri Department of Elementary and Secondary Education and Illinois State Board of Education to ensure support for local school efforts and sustainability going forward.
  - Support funding for geospatial experiential learning opportunities and activities by engaging geospatial companies and employees for classroom and site visits, internships, apprenticeships, career mentoring, etc.

Regional Organizations and Initiatives Engaged in Geospatial and Broader "STEAM" Education and Training

- **Cortex** hosts a broad range of educational and research programming including:
  - **COLLAB**, a joint initiative between SLU and WashU to harness university capabilities to accelerate innovation and growth through collaboration includes geospatial-related educational programming in cybersecurity, IT and engineering; and a platform for collaboration in areas such as geospatial research.
  - **Gateway Higher Education Cyber Consortium (GHECC)** is a newly-created organization comprised of local universities with educational and research interest in cybersecurity. The GHECC aims to guide cybersecurity students, educators and practitioners in the greater St. Louis region through collaboration in support of the growing field of cybersecurity, and to promote education, industry development and help fill regional job demand.
  - **EdHub STL** represents a physical space in Cortex for educators to collaborate and experiment, as well as for dedicated educational programming, events, summer experiences.
- **CyberUp** is leading workforce development and introducing youth to the field of cybersecurity with a mission to close the cybersecurity skills gap by training the workforce of today and inspiring the workforce of tomorrow. CyberUp uses a Registered Apprenticeship model combined with online training to develop entry-level cyber professionals who can exit the program with an industry-recognized certification(s). The organization also connects youth with cyber-related camps, clubs, and competitions.
- **Gateway GIS** is a new program now completing its first year in operation. It focuses on program development and implementation by representatives of academia, government, industry, and non-profit organizations that volunteer to fulfill the needs of a geospatial workforce development pipeline, starting with integration of GIS into STEAM education for Pre-K to 12 students from North City neighborhoods. The program is offered to students through school day, afterschool (at local Boys & Girls Clubs) and weekend programming and is designed to connect students with career preparation and entrepreneurship in GIS and STEAM through the use of real-world applications and projects, internships for high school students, monthly seminars, train-the trainer activities, and more.
- **Gateway Global American Youth and Business Alliance** is an education management organization that teaches youth and young adults how to connect critical STEM to something they understand – people, places, and things. Gateway Global does this through Global Lab, an online learning platform focused on five big themes related to International Relations and Critical Infrastructure. Recognizing the need to increase career awareness and workforce training opportunities among K-12 students for the region's growing Geospatial hub, the organization is focused on implementing K-8 programming which includes a Charter School focused on geospatial science set to open Fall 2020 just blocks from NGA West. At the high school level, providing the Global Lab platform to catalyze interest in geospatial science and related areas of IT and cyber-physical systems as well as a 12th grade Capstone that culminates into apprenticeships, externships, and an option to earn industry-recognized, USGIF approved micro-credential. To create jobs for apprentices, Global Gateway has recently launched a for-profit, MBE/WBE geospatial data governance and mapping firm.
- **LaunchCode**, founded in 2013, is building a skilled workforce by creating pathways for people seeking careers in technology. LaunchCode helps jobseekers enter the tech field by providing accessible education, training and paid apprenticeship job placement, as well as career coaching and mentoring. The organization has a broad set of programming for individuals from all backgrounds taking them from no previous coding experience to the skills needed to land your first tech job. In addition, LaunchCode has worked closely with incumbent workers at NGA to increase their in-house development capacity. LaunchCode has had a significant impact with 84 percent of its apprentices converted to full-time employment, on average they double their salary, and over time the organization has helped to launch about 2,000 tech careers in the region.
- **NGA, through its Partners in Education program** and with assistance of the SLAWG is engaged with 4th graders in the SLPS around geography-based learning and competitions and other geospatial education activities.
- **SIUE** has partnered with local schools in the region, including with Collegiate School and Edwardsville Schools in their AP Geography classes and GIS applications. With Edwardsville schools the University partners built up AP Geography and modified it to make it more hands-on with integrating GIS technology, implementing GIS projects, and holding TED-style presentations. At Collegiate, they are developing a 3-course sequence including AP Geography and Advanced GIS and training teachers.
- **T-REX/Geosaurus** has extensive education and workforce development activities with some underway, and others being planned for the new Geosaurus organization. In plans to develop the talent pipeline for the geospatial industry are: summer high school GeoCamp; high school internships; lunch and learn workshops for presentations to middle school and university students; two academic classrooms for hosting a variety of workforce development initiatives. Geospatial networking is already happening through the "Geosaurus Unleashed" speaker sessions and learning events.

- Consider developing a St. Louis Mobile Geospatial Lab to reach more schools, neighborhoods, community events, etc., particularly in disinvested neighborhoods. The Mobile Lab could be equipped with interactive GIS, drone, and other geospatial technology demonstrations, career exploration information, and more. Regional industry and universities should partner on the Mobile Lab.
- Support intentional pathways to certificates and micro-credentialing, even for high-schoolers, to recognize training in hard-skills such as GIS or Drone Piloting that are marketable to regional employers and enhance collegiate applications, while motivating students to participate.

- **Address the demand for "hybrid" geo-technical skills development.**
  - Enhance college and university education programs in computer and data sciences with a strategic focus on geospatial applications and use cases. Embed within these programs specific project examples, case studies, and industry-engaged "capstone" projects or internships in geospatial applications development as employers have a preference for workers with these experiences.
  - Implement within the region a hybrid computer science and Geosciences/GIS major degree program such as the "CS + X" degree offered at the University of Illinois.[24] The Illinois program recognizes the need for hybrid skill and knowledge development and "allows students to pursue a flexible program of study incorporating a strong grounding in computer science with technical or professional training in the arts and sciences." One of the U of I CS + X programs includes Computer Science + Geography and GIS.

- **Develop a National Security cohort track among postsecondary computer and data science majors.**
  - Create a specific track within relevant major degree fields such as computer and data sciences with a simultaneous, intentional pathway for students to gain security clearances, access summer immersion opportunities, focused scholarships, and internships and apprenticeships. Engage and work with NGA contracting companies, as well as USGIF to inform and participate in each of these elements, with an explicit commitment to hiring qualified program graduates.
  - Develop scholarship opportunities for the National Security Track that are accessible only for students in disinvested regional neighborhoods and communities, particularly those that have participated in K-12 geospatial programming.

- **Engage "adult learners" for geospatial application training or re-training and as a key pipeline for geospatial talent.** Two key populations for strategic interventions and programming include:
  - Veterans, who represent a key source of "cleared" talent for the national security sector and a diverse and experienced population from which to draw; and
  - Regional adult residents with some college education, but who lack a degree. These individuals number approximately 400,000 in the region and the State of Missouri's new "Fast Track" financial aid program could be tapped to cover the full costs of education for those pursuing a certificate, an industry-recognized credential, or a bachelor's in a high-demand field.[25]

- **Create geospatial career pathways bridged by community college programs and 2-year degrees.** Employers acknowledge needs for GIS and routine geospatial "production" work, and hiring managers are often receptive to candidates with Associates degrees and technical skills, but are often constrained by formal job requirements. At the same time, regional community colleges are receptive to developing geospatial-specific certificates,

24 For more information see: https://cs.illinois.edu/academics/undergraduate/degree-program-options/cs-x-degree-programs.
25 For more information on Missouri's Fast Track Workforce Incentive Grant, see: https://dhewd.mo.gov/initiatives/fast_track.php.

degrees, or other credentials if a demand for graduates can be demonstrated. Engaging the region's community colleges is another way to ensure increased diversity and inclusion in the geospatial sector, as the community college system engages a much more diverse and non-traditional student body. Actions to be taken include:

- Explore and create demand for community college graduates with technical skills in GIS, cybersecurity, network engineering, software development, and other geospatial and tech-related hard skills. Facilitate intentional dialogue by convening focus groups of hiring managers, HR reps, and community college leadership to explore demand and to direct and inform educational and experiential programming for 2-year graduates.
- With demonstrated demand, geospatial companies should consider post-graduate internships and/or 6-month trial employment arrangements with graduates of 2-year degree programs. Once hired, consider incentivizing career development and progression by funding further postsecondary education in key geospatial degree fields.
- Employers should consider implementing "skills-based" hiring practices to re-frame job postings, particularly for those that involve more routine daily tasks and duties, to focus more on technical skills and experience requirements, without simply assuming requirement of a 4-year degree. This skills-based approach is taking hold nationally, particularly given the current inability of employers to find technical talent, or to find bachelor's-level talent graduating with hard skills.

- **Collaborate regionally to pursue federal grant funding for geospatial education and training programming.** This should include exploring the NSF's Advanced Technological Education (ATE) program and center grant awards. The ATE program uses community colleges in leadership roles and focuses on educating and training highly qualified science and engineering technicians in targeted industry and technology areas, in close partnership with industry, government agencies, and secondary through post-secondary institutions. ATE target areas include Geosciences and Geospatial, with other regions successfully winning and utilizing sizable grants for key activities such as: geospatial professional development training to high school teachers; educating technicians in geospatial technologies such as GIS, spatial analysis, CAD techniques, etc.; funding internships to provide one-year experiences to new geospatial graduates, and much more.

- **Establish a geospatial talent college internship program.** Internships are widely-recognized as valuable to both interns and employers; however, chief barriers and challenges for establishing substantive and scaled-up internship experiences are often the process of matchmaking and content development—finding interns and creating meaningful tasks and experiences for them to engage. Geospatial employers have recognized the value of hosting interns, including the importance of identifying top students early in their collegiate experience to engage them in multiple internships to ensure work-readiness and a good fit. A geospatial-specific internship program would seek out and post opportunities from local industry and act as a clearinghouse and match-maker with local colleges and universities, and their respective career offices and students.

RECOMMENDED STRATEGIC IMPLEMENTATION APPROACH:

The current geospatial-related education and talent ecosystem for St. Louis is characterized by an eagerness to pilot, experiment, and try new approaches, often through novel grassroots efforts just getting underway. This is a positive situation no doubt, but one that requires bolstering current efforts that are demonstrating success with resources to achieve scale. To advance these goals, and to narrow or close identified talent gaps and needs, the region should undertake and implement the following recommended strategic approaches:

ORGANIZE AND STAND UP THE GEOFUTURES TALENT INITIATIVE AS A COMPONENT OF THE GEOFUTURES COALITION

Objective: Support and deepen ongoing K-16 and adult workforce geospatial-related technical education provider efforts, with a particular focus on under-represented communities.

Activities:

- Act as a strategic investor and coordinator of geospatial-related education and training efforts
- Play a key liaison role consistently monitoring industry supply-demand conditions for talent and translating industry needs to academia as an interface with the regional SLAWG group, as well as with NGA and with USGIF.
- K-12 and Workforce Development –
  - Grant-making function dedicated toward supporting and deepening the ongoing geo-spatial STEAM programs, as well as overseeing efforts to pilot and advance new ones.
  - The grant-making function would be accom-panied by an oversight and performance monitoring role to track investments in terms of program progress, accountability, and determining what is working well and should be further scaled, and what is not.
  - Technical assistance and funding support to targeted school districts
- Post-Secondary –
  - Support curriculum development, including stackable skill modules
  - Scholarships and internships for disinvested students

Best Practice Example: Ohio Supercomputer Center

The Ohio Supercomputing Center has garnered a national reputation for its K-16 training and education programs in advanced computing and data sciences.

At the K-12 level, OSC has well-established summer programs. One effort, known as the Summer Institute, is a two-week summer camp for high school freshman and sophomores that teaches students computing fundamentals such as programming language, parallel processing techniques and visualization toolkits. Another effort is the Young Women's Summer Institute, a week-long program for middle-school girls designed to promote computer skills and broader STEM education with hands-on experience in having students work on a practical, interesting scientific problem using the latest computer technology.

OSC also created back in the mid-2000s a virtual school for computational science to enhance undergraduate education across the state. Known as the Ralph Regula School for Computational Science, it attracted NSF support to create a statewide undergraduate minor in computational science across a multi-university consortium and to develop an associate degree in computational science as the middle two years of an articulation from high school to community colleges and then 4-year colleges and universities. The approach is focused on interdisciplinary application of computational sciences to allow undergraduates to apply to their area of study.

- Adult Learners –
  - Target veterans, people with some college and underemployed
  - Integrated short-term training, emphasizing stackable skill modules, and placement services

Governance: The STL GeoFutures Coalition would oversee the STL GeoFutures Talent Initiative, including the approval of funding

Operations: The STL GeoFutures Coalition would budget, staff and oversee the grant-making function

Strategic Priority B: Raising Innovation Capacity for Advanced Geospatial Technology Applications for Leading Industry and Community Development Drivers

STRATEGIC NEED FOR ST. LOUIS

Despite the increasing integration of geospatial information and applications in how we live and work, it is not widely recognized that the use of locational data through advanced technologies derives from a complex interplay of university research with advanced industrial and government applications. For instance, in the 1980s and 90s, the advanced communication and computational needs of the U.S. military led to collaborative research with academic partners that incubated innovations that evolved into today's multi-scale data communication systems from space, mobile and longline, and its integration into the Internet, which underpins all aspects of the modern, global economy. Silicon Valley, Boston, and Washington D.C. were among the first regions to cash in on this revolutionary new technology in part because the programmers, scientists, and engineers that made the original discoveries were located there.

A close examination of how advanced computer applications progress reveals that there is a high degree of interaction linking industry and academic research. Ideas flow back and forth between university research programs and industry development efforts.[26] Research universities, in particular, offer industry a wide range of information technologies and expertise to draw upon that are becoming increasingly important—going beyond just electrical engineering and computer science to such areas as data sciences, cognitive science, and modeling and simulation.

As was the case with the development of the Internet, research universities are playing a critical role in the emergence of geospatial technologies and applications in diverse fields such as digital/precision agriculture, autonomous vehicles, Big Data predictive analytics and Internet of Things (often referred to as cyber-physical systems in academia), among other fields. Research universities keep pushing the boundaries of remote sensing, Big Data analytics, autonomy, network science and engineering by being "way out in front" of commercial markets through more science-driven applications and innovations.

The competitive benchmarking analysis reveals that St. Louis has only modest levels of R&D and innovation taking place, with $39 million in academic research in geospatial-related fields for 2017 and a mere 122 total patents invented in geospatial technology areas from 2015-18. Not surprisingly, industry does not view St. Louis as having a top-notch university geospatial research program in place today. While there is an existing base of university applied research efforts in St. Louis that does connect with industry in the region, industry executives interviewed mentioned that they work with universities outside of the broad St. Louis region for their more extensive collaborations on innovation. This points to the importance of supporting the enhancement of research capacities across universities in the broad St. Louis region, while also capitalizing on collaborations among the universities around targeted development opportunities.

Across industry and university, there was support voiced for the Center of Excellence in Geospatial Technologies and Applications that spans universities like Danforth Center does in agbiosciences, which could focus on market-driven challenges, promote hackathons, and create test-beds and demonstration sites. Most importantly, it needs to create the communities of innovation around geospatial development that can strengthen St. Louis' capacity to be a leader in advanced technology applications.

An untapped resource for the St. Louis region to build a broader research and innovation base is to engage the University of Illinois, Urbana Champaign (UIUC) as a collaborator in a Center for Excellence. In recent years, UIUC's National Center for Supercomputing

26 *Report of the Panel on the Network Systems and Communications Industry in National Academy of Engineering, The Impact of Academic Research on Industrial Performance, 2003, page 40.*

Applications has been advancing collaborations with NGA. With an initial $11.1 million in funding from the NGA, UIUC has been leading a consortium to create the most powerful dedicated, non-classified geospatial system in the world, capable of bringing unprecedented speed and efficiency to global mapping. This effort is leading to the production of digital elevation models of the entire Earth that will benefit community planning, water resource management, and seismic activity assessments, among other uses. These efforts tap the extensive capabilities of UIUC, whose research funding in key geospatial related fields stood at 4.5x the size of all St. Louis universities in 2017, with $103 million in computer science research, $56 million in electric engineering and $12 million in aerospace engineering. UIUC also has a leading university-wide center involved in advanced digital and spatial studies, known as the CyberGIS Center, and recently launched a Center for Digital Agriculture, tapping expertise across its colleges of agriculture and engineering with the supercomputing center. UIUC is also well-known for its CS + X undergraduate programs that allow a student to pursue a flexible program of study incorporating a strong grounding in computer science with education in a domain area, such as geography, crop sciences and other fields, creating the hybrid skill sets in strong demand by geospatial companies.

Within the targeted sectors for geospatial development in St. Louis, there are broader headwinds to be addressed around innovation. A critical means to generating innovation is to tap its larger geospatial-oriented businesses to define market needs and provide the customer discovery and first customer adoption. This does not happen easily today in St. Louis beyond a few leading firms, such as Bayer and Enterprise. More generally, St. Louis' corporate sector is viewed as a late adopter of new technologies so an organized effort is required to unlock the potential for market-driven innovations.

For the national security sector, there is a more fundamental concern and opportunity to seize. The nature of NGA activities in St. Louis has been historically focused on contract services and so the technology mindset has tended to focus on demonstrated competencies in existing systems and applications. In the past, there has been little access in St. Louis to the research and development arm of NGA involved with broader thinking about addressing technology challenges. One result is that there is little to no funding of Small Business Innovation Research (SBIR) Grants in geospatial topics from the Department of Defense to innovative small businesses in the St. Louis region. But the New NGA West headquarters is heralding a new era for innovation in St. Louis that must be embraced broadly by the community. It will offer a dedicated, unclassified site where collaborations on innovation take place. This includes a Software Development Lab that is already being established at T-REX while construction is underway, and in the future may include advancing a dedicated national security geospatial accelerator.

Smart City initiatives are also seen as a critical means for advancing innovative uses of geospatial tools to address community needs and improve the built environment in St. Louis. The City of St. Louis is focused on advancing Smart City applications, including recently launching Smart City interactive kiosks in historic Old North St. Louis and downtown with plans for up to 50 additional kiosks in neighborhoods across the city. The City of St. Louis, in collaboration with T-REX, also undertook a pilot to research, design and test the Smart City Interoperability Reference Architecture that integrates commercial Internet of Things sensors for public safety applications. There is an opportunity to collaborate with the City of St. Louis on Smart City efforts partnering around its unique platform of 3D map of city that is underdevelopment along with access to city data. But currently there is no funding mechanism in place even for pilot efforts.

Others in St. Louis are looking into the advancement of population health management. A broad community-wide effort is underway to create a Community Information Exchange in the St. Louis region similar to that in San Diego that is now managing over 200,000 referrals a year for at-risk patients to access needed health and social supports. More recently, the COVID-19 pandemic is helping a new partnership to take form involving the region's major healthcare systems, health departments and research universities to share data that in the future can offer a platform to enable broad applications of geospatial health-related applications to address significant health disparities and population health needs across the St. Louis region.

ONGOING REGIONAL ACTIVITIES:

This is an exciting time for university research and development activities related to geospatial development. In the last year, many new initiatives have been announced and there is strong university leadership to see enhanced capabilities in technology areas directly relating to geospatial technologies and applications.

Examples of these new university research and development initiatives include:

- Saint Louis University's Geospatial Institute
- Southern Illinois University-Edwardsville Center for Predictive Analytics
- University of Missouri NextGen Precision Health Initiative and Institute
- University of Missouri Transportation Center for Innovation
- Missouri University for Science & Technology Faculty Recruitments in GeoPhysics
- Global Center for Systems Security, Privacy and Trust at Cortex

Plus, Geosaurus at T-REX is actively involved in advancing supportive infrastructure and programming for geospatial-related innovation. This includes visualization tools, a robust cloud-based data environment, the presence of NGA's software development lab and program activities to address hard problems facing government and military organizations in the use of geospatial technologies and applications. Geosaurus at T-REX is also seeking to create an augmented reality/virtual reality simulation studio and is collaborating with local and national strategic partners to establish the Midwest Extended Reality and Simulation Consortium.

Below is a listing of the wide-range of existing and emerging major research programs/centers found in all aspects of geospatial-related research:

TABLE 5: LISTING OF MAJOR ST. LOUIS REGIONAL UNIVERSITY RESEARCH PROGRAMS AND CENTERS BY TECHNOLOGY FIELDS RELATING TO GEOSPATIAL ACTIVITIES

Technology Field:	University Major Research Program/Center
Geo-Information Systems	• Mizzou Center for Geospatial Intelligence is a university-wide center for national security and defense related geospatial research with a dedicated SCIF with NGA — $2.6 million in funding in FY 2018 • SIUE Laboratory for Applied Spatial Analysis (LASA) • SLU launched university-wide Geospatial Institute (GeoSLU) as an area of distinctive research bringing together ongoing research involving geospatial applications for climate change; food, water and human insecurity; economic development and social instability; geospatial health; geospatial biology; transportation and supply chain
Geophysical/ Remote Imaging	• Mizzou Department of Electrical Engineering and Computer Sciences has strong faculty research in remote sensing and image processing • MUS&T Department of Geosciences, Geological and Petroleum Engineering brings a geophysical focus to remote sensing using LIDAR, Synthetic Aperture Radar, and multi-scale analysis of geospatial imaging data. Recent hires in geophysics measuring gravity and magnetic fields remoting for uses in geomatics • SLU Remote Sensing Lab focusing on land cover and land use mapping using multispectral, hyperspectral and active microwave imaging technologies • WashU has a leading national Imaging Science Program that is cross-university with a strong emphasis in biomedical imaging, but also active faculty research in security applications, radar, wireless and RF sensing networks, sensor actuated networks and autonomous driving. Plus Earth and Planetary Remote Sensing Laboratory focuses on surface processes and histories of Earth, Mars, and Venus and is home to one of NASA's Planetary Data System Geosciences Nodes that hosts planetary data online for public access
Cybersecurity	• Mizzou designated in 2019 as National Center in Cyber Defense Research by NSA/ DHS with research focus in cloud-based and web security including applications in healthcare, education and manufacturing • MUS&T designated as National Center in Cyber Defense Research by NSA/DHS with emphasis on cyber-physical security for critical infrastructure as well as ongoing research in mobile systems, enterprise IT security, cloud and sensor security • WashU is actively advancing its cybersecurity program with a focus on cyber-physical systems including security of hardware and software, as we;; as leading the formation of a Global Center for Systems Security, Privacy and Trust involving leading companies in the region with SLU and Cortex
Machine Learning & Data Analytics	• Mizzou in School of Engineering has targeted Big Data Analytics as a research pillar; university-wide Institute for Data Science & Informatics with 44 core faculty members; leading area of research focus for Center for Geospatial Intelligence • MUS&T Computer Science Department focus on image analysis and computer vision, machine learning for image classification, neural networks • SIUE's new Center for Predictive Analytics • SLU's new GeoSLU key areas of research investment will be in enhancing data analytics infrastructure, including recruitment of lead Geospatial Data Scientist • WashU's Department of Computer Sciences & Engineering has a strong emphasis on ML & AI with 12 active faculty researchers, plus a cross-university Machine Learning & Artificial Intelligence Group has been formed with CSE, biomedical faculty and social sciences faculty. Plus, Olin School of Business has a Center for Analytics and Business Insights

Technology Field:	University Major Research Program/Center
Cyber-Physical Systems/IoT/ Smart Cities	• Mizzou new industry supported consortium for Cognitive Internet of Things for Intelligent Communities • MUS&T Smart Living university-wide signature research area; Intelligent Systems Center, recently graduated NSF-funded Engineering Research Center • UMSL has received National Science Foundation funding to advance edge cloud computing for supporting IoT applications • Washington University's Department of Computer Science & Engineering brings a strong focus on cyber-physical systems research on real-time systems, IoT, wireless sensor networks that includes 10 faculty members
Transportation & Logistics	• Mizzou Department of Civil and Environmental Engineering brings a focus on transportation research, including driverless trucks and intelligent transportation systems. Helping to lead a new Missouri Transportation Center for Innovation. Plus, NSF-supported Center for Excellence in Logistics and Distribution • SLU School of Business Center for Supply Chain Excellence • UMSL university-wide Center for Transportation Studies including network analyses and inventory rationalization studies, simulation of congested transportation systems, use of drones and trucks for delivery • WashU Boeing Center for Supply Chain Innovation

PROGRAMMATIC ACTIVITIES AND ACTIONS NEEDED:

Advance applied geospatial innovation activities, leveraging existing resources and ongoing activities, such as Geosaurus at T-REX and across university-related centers of excellence, that focuses on value for business functions, showcases capabilities of geospatial technologies, advances business use cases, helps identify customers and de-risk applications with proof-of-concept funding

Establish a Geospatial Research Center of Excellence that spans universities like Danforth Center in agbiosciences, builds collaborations, targets recruitment of top researchers and advances commercialization

Create a mechanism to match university faculty expertise with industry needs

Create a "first customer program" to identify and match entrepreneurial companies with existing businesses needing geospatial solutions

Be a leader in state and local government use of geospatial technologies and applications, including being a national leader in **Smart Cities**

RECOMMENDED STRATEGIC IMPLEMENTATION APPROACH:

There are many specific tactics that can be advanced to address raising innovation. These include: matching expertise of faculty to industry needs, offering hackathons around key challenges facing leading sectors, offering planning and pilot grants for Smart City applications. But a piecemeal approach will not generate the results needed. Instead, a signature investment is proposed in a comprehensive approach.

ESTABLISH A GEOFUTURES INNOVATION COLLABORATIVE

Objective: Address the opportunity and challenge to "establish STL as a leader in advanced technology applications of locational data" that can drive national security, commercial and community innovation, commercialization and entrepreneurship

Best Practice Example: Oregon Nanoscience and Microtechnologies Institute

The Oregon Nanoscience and Microtechnologies Institute (ONAMI), was formed as an industry-led Signature Research Center, representing a collaboration of four Oregon universities (Oregon Health and Science University, University of Oregon, Oregon State University, and Portland State University), a national laboratory (Pacific Northwest National Laboratory), industry, and the investment community.

Among its principal activities is furthering commercialization and new company formation, tapping into entrepreneurs-in-residence with domain experience in key applications of nanoscience and microelectronics, such as semiconductors, sensors & optics and smart energy & energy storage, with competitive access to proof-of-concept funding and pre-seed/seed funding. ONAMI also provides matching funds for federal and private collaborative research projects, and enabling industry access to a collection of university-based shared-user facilities.

ONAMI points to several key successes in its first decade:

- Through its sustained support of coordinated shared-lab facilities at universities and collaborative research efforts of under $25 million, ONAMI has spurred nanoscience and microtechnology university research in Oregon from $9 million back in 2004 to consistently above $30 million annually, with total funding of over $360 million through 2015.
- Industry support of university research has been significant, growing to $36 million in equipment, facilities, and services.
- 45 business start-ups were generated with ONAMI support of $7.9 million in commercialization gap funding, leveraging an additional $165 million in follow-on funding from private investment and SBIR funding

Activities:

- Engage industry, university and community partners to focus on targeted industry and community drivers for advancing geo-related applications
- Identify market-driven applications development needs through customer engagement, workshops and conferences and white paper development
- Offer competitive commercialization grants for early-stage geospatial-related tech startup ventures that includes funding for proof-of-concept projects and for free or discounted space, with follow-on funding available for successful startups through a matching venture capital investment fund
- Support matching grants for applied R&D projects with industry to partner with universities and emerging IT startups
- Provide university research enhancement funding in emerging technology areas, such as quantum computing, cyber-physical systems and autonomous systems
- Support site minders at universities and research institutions to tap expertise
- First customer program that assists emerging technology companies with identifying potential customers, gaining introductions, and closing sales with these early adopter customers
- Demonstration and testing center

Governance:

- Independent non-profit organization; industry-led board, with representation of university VPRs, federal labs and research organizations

Operations:

- Involve entrepreneurs-in-residence to lead effort; require technical staff to oversee demonstration/testing center

Strategic Priority C: Accelerating Entrepreneurship and Availability of Risk Capital

STRATEGIC NEED FOR ST. LOUIS

While the focus of St. Louis' geospatial development in the near term will be to leverage regional strengths in leading industry sectors, such as national security, agtech, transportation & logistics and healthcare delivery, the presence of a robust entrepreneurial base of companies to engage with these existing industry strengths will be critical for St. Louis to be a global hub in geospatial development. In an era of open innovation, where established companies seek out innovations from outside of their own corporate R&D activities, being able to engage with entrepreneurial businesses is essential.

For geospatial development and the broader "tech" sector, St. Louis is only just emerging in entrepreneurial startup activity. The competitive benchmarking analysis suggests that St. Louis has only a modest level of both entrepreneurial companies and venture capital funding directly involved in geospatial development, and is lagging the levels of other benchmark regions. A deeper analysis of the broader "tech" sector suggests that the number of startups in St. Louis able to attract pre-seed, angel investor or seed investments numbers just over 100, and is roughly one-quarter of the number of other comparable regions such as Denver, Philadelphia and Washington, DC. At the same time, follow-on financing to St. Louis tech-based companies is at much lower levels than other regions, with only 43 percent receiving any form of formal venture, private equity or other financing or buy-out (see Table 6). This can reflect both a lower quality of St. Louis tech startups as well as the lack of a strong pool of formal venture capital at Series A and beyond in St. Louis.

According to discussions with stakeholders, this is not surprising or discouraging. The focus on tech startups began roughly ten years ago in St. Louis and has not yet reached the level of maturity as life sciences entrepreneurship that began nearly a decade before. St. Louis is now at a point where it has established a base of activity in tech startups and can build upon that going forward. The fact that total venture capital funding in St. Louis for tech startups increased by 146 percent from the 2010-14 period to the 2015-19 period suggests St. Louis is on the right trajectory. Plus, there are a growing number of examples of successful geospatial startup companies in St. Louis that point to the potential for future.

TABLE 6: BROADER TECH STARTUP ACTIVITY SINCE 2010 AND FOLLOW-ON FINANCING

Region	Startups Since 2010	Share of Startups Since 2010 Receiving Follow-on Financing
St. Louis	101	43%
Denver	442	74%
Philadelphia	345	70%
Washington, DC	494	67%

Source: TEConomy's analysis of PitchBook Database. Broader Tech sector includes: All venture-backed companies involved in Information Technology sector, including software, IT services and communications/networking. All other venture-backed companies involved in technology verticals including: Adtech; Agtech; AI & ML; Autonomous Cars; Big Data; Cybersecurity; E-Commerce; EdTech; FinTech; HealthTech; Infrastructure; IoT; Marketing Tech; Mobile; Robotics & Drones; SaaS; Virtual Reality; and Wearables

Still, there are concerns voiced by geospatial entrepreneurs and stakeholders on the overall level and quality of startup activity in geospatial and broader tech development. A missing element in St. Louis is having larger corporate customers in national security, transportation and logistics, digital/precision agriculture, and healthcare delivery engaged with entrepreneurs to define key innovation needs around the use of location data that can be addressed by geospatial technologies and applications. This missing element is closely tied to the broader innovation challenge facing the St. Louis region around geospatial development, and so entrepreneurial development suffers without being closely tied to advancing innovation.

Geospatial entrepreneurship in St. Louis for national security offers its own specific opportunities for startups, but also poses its own challenges. The opportunity for startups and emerging small businesses is that NGA embraces small company set-asides, and so an ecosystem between large DoD contractors and small companies offering niche technology services is present and can grow. Given that many of these startup and emerging small businesses in national security are focused on providing highly technical contract services rather than new product development, it makes them less likely to attract venture capital sources. Instead, these national security startups are dependent upon traditional banking sources that do not understand how government contracting works and are often reluctant to help mobilize around a new contract or to fund scaling-up the capacities of a business to meet specific opportunities.

What is discouraging for St. Louis is its limited engagement of Black entrepreneurs in geospatial and broader tech development. African-Americans are significantly underrepresented in the share self-employed in geospatial-related industries, with just 3 percent compared to 9 percent of the workforce. Moreover, the St. Louis Business Journal reports that none of the region's top venture funding deals last year, for example, involved a company with a Black founder.[27] A survey of Black entrepreneurs by WePower found that 74 percent cited access to capital as a current challenge.[28]

Examples of Successful Venture Capital-Backed Geospatial Startup Companies in St. Louis

- Agilis Systems, a leading provider of fleet and workforce management solutions that provides robust location-based solutions through an easy-to-use software-as-a-service (SaaS) platform
- Aisle411, a location services platform that allows retailers to develop searchable store maps to help consumers better navigate through stores
- Boundless, an open source geographic information software provider recently acquired by Planet
- Coolfire Solutions, a mobile software platform that provides real-time situational awareness across devices
- RF Controls, a provider of ultra high radio frequency identification applications for real-time, automated location and tracking

ONGOING REGIONAL ACTIVITIES:

The St. Louis innovation-led entrepreneurial support community has made significant strides in recent years. Beginning with the Plant and Life Sciences Roadmap, the St. Louis community has been advancing its entrepreneurial support system. One of the stakeholders now estimates that nearly 1,000 innovation-led startup companies are being supported by the region's entrepreneurial support system.

While the data suggests that formal venture capital for tech development is not strong in St. Louis, the earlier stages of entrepreneurial support involving guidance and coaching on business concept development to company launch and angel/seed investment are in place for local tech-based startups. This entrepreneurial support system geared towards tech-based startups includes:

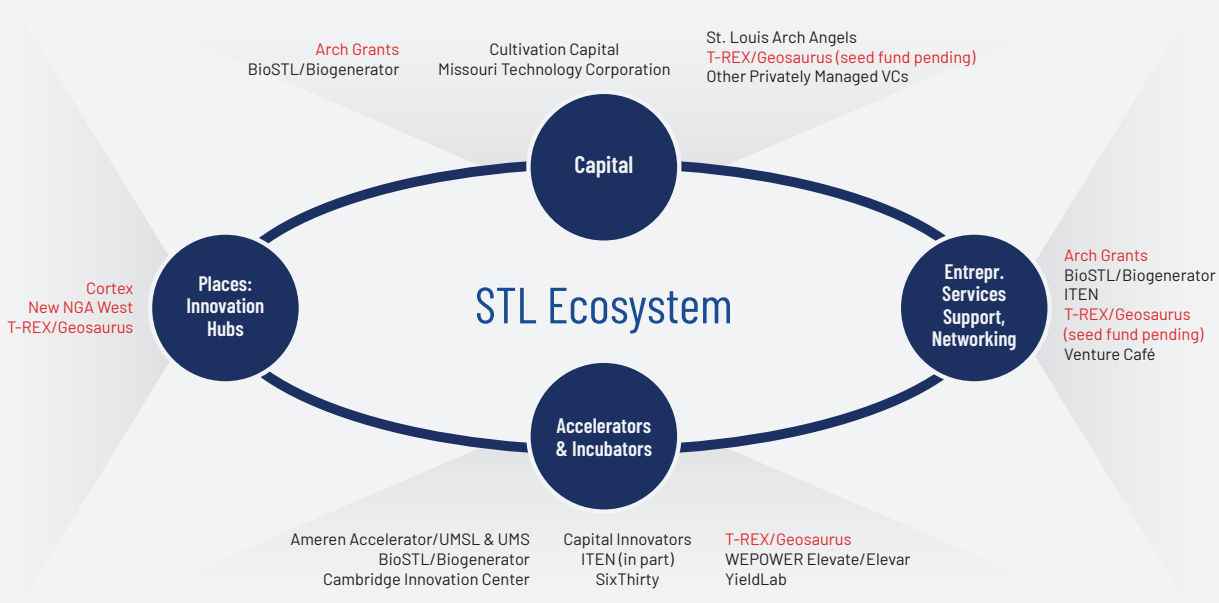
27 *"Cultivating a fair ecosystem," St. Louis Business Journal, January 30, 2020*
28 *WEPower, Dream of Change Report*

- Two significant innovation hubs offering networking and coworking space, with Cortex and T-REX/Geosaurus
- Early entrepreneurial mentoring support through ITEN
- A unique organization to attract entrepreneurs to St. Louis with a $50,000 equity-free grant and pro bono support services through Arch Grants
- A number of accelerators and commercialization organizations to help entrepreneurs advance their business model and gain important mentoring services, with access to follow-on funding in some cases.
- An active angel investor network, St. Louis Arch Angels
- An active seed investor, Cultivation Capital, with multiple funds able to follow-on from pre-seed and angel investors and co-invest in early rounds with formal venture capital funds

Figure 27 below depicts this robust entrepreneurial support system currently in place. What stands out is that many of these entrepreneurial support providers are beginning to actively focus directly on geospatial development. For instance, Arch Grants recently announced a dedicated funding cohort focused only on geospatial companies. Cultivation Capital is in the midst of raising a seed fund for geospatial as is T-REX/Geosaurus. Plus, some of the existing entrepreneurial support organizations have targeted lead industry sectors related to geospatial, including the BioGenerator and Yield Lab that provide a focus on digital/precision agriculture.

When it comes to assistance for Black entrepreneurship in innovation-led companies, however, there are more limited resources. WEPOWER just launched a new accelerator for Black and Latinx entrepreneurs, known as the Elevate/Elevar Accelerator. It was formed as part of the Village Capital community, and offers access to capital, training using Village Capital's tested curriculum, business coaches and mentors, professional business support services and co-working space. Its first cohort of ten Black and Latinx entrepreneurs were selected based on over 90 applications. Among this first cohort are a number of more innovation-led startups, including a mobile gaming company, a custom furnishing company and a software platform for roadside assistance. There are other efforts underway including the St. Louis Equity in Entrepreneurship Collective, sponsored by BioSTL and funded by the Kauffman Foundation, which is collaborating with Forward Cities to develop an overall strategic plan for the region.

FIGURE 27: DEPICTION OF REGIONAL INNOVATION ECOSYSTEM SERVICE PROVIDERS



*Orgs with Geospatial-specific programming initiatives shaded in Red

PROGRAMMATIC ACTIVITIES & ACTIONS NEEDED:

Key elements of the entrepreneurial actions recommended for geospatial development by stakeholders relate to St. Louis being more intentional in driving innovation based on defined market needs and customer discovery. This calls for **advancing applied geospatial innovation activities**, leveraging Geosaurus at T-Rex and university-related centers of excellence, that focuses on advancing business use cases for new geospatial applications that offer tangible value for improving the operations and enhancing the growth of businesses across different industry verticals, showcases capabilities of geospatial technologies, and helps identify customers and de-risk applications with **proof-of-concept funding.** In this regard, the proposed STL GeoFutures Innovation Collaborative will play a lead role in helping to raise entrepreneurial deal flow for geospatial development.

Beyond the gap in entrepreneurial deal flow, two other critical activities were identified in discussions with stakeholders:

- **St. Louis needs to have available a pool of follow-on financing that can co-invest with outside venture capital and incentivize local traditional financing sources to provide scale-up funding to national security geospatial government contractors.** Discussions with stakeholders identified that St. Louis is still emerging in tech-based startups, but that the entrepreneurial ecosystem is maturing and that rather than a new direction, it would be better to provide a means to facilitate and enhance the ability of existing venture funding sources to syndicate with capital from outside the region in providing scale-up funding for geospatial-related startups. An efficient and sustainable approach will be to focus on qualifying St. Louis geospatial companies for matching investments that can be used to leverage funding from other sources of capital, including from outside of St. Louis. For emerging St. Louis geospatial startups, the critical time would be as they seek their Series A round of investments and, in essence, would offer an incentive to share the risk with formal venture capital funders. It also has the advantage of allowing the market to determine valuation and terms and have the STL GeoFutures Initiative simply act as a "silent" co-investor.

  For national security government contractors, the approach to matching investments would involve more co-investment with traditional bank sources of financing. This could also be achieved through a loan guarantee mechanism. Another alternative to consider would be to form a federal Small Business Investment Company with a consortium of banks that can leverage significant matching sources from the federal government.

- **A targeted Black tech business development effort is needed in St. Louis to raise awareness and provide resources for Black and other under-represented professionals working in geospatial-related fields to have the option to pursue business ownership.** To complement the broader activities of WEPOWER's Elevate/Elevar accelerator and future directions by St. Louis Equity in Entrepreneurship Collective, the STL GeoFutures Initiative should focus on cultivating relationships with Black professional associations of IT and engineering professionals to provide entrepreneurial services to their members, as well as other Black tech professionals. Best practices suggest the importance of offering a formal programming approach that helps Black professionals consider the option of starting their own businesses, including training and coaching in customer discovery and business concept development. For those who successfully complete this formal programming, it would be important to have pre-seed funding of up to $50,000 to further validate the commercial viability of their business plan concept, as well as to take the steps to formally launch their new businesses and acquire initial first customers. At the stage of pre-seed funding, it would be important to integrate these new Black-owned startups into the broader entrepreneurial ecosystem by creating mentoring relationships with groups such as St. Louis Arch Angels, Cultivation Capital, and other private venture capital sources.

Additional activities to consider in support of Black tech entrepreneurship include:

- Supporting business matchmaking events for Black-owned tech startups and early stage companies with established technology companies and potential company customers
- Assisting in Black-owned tech startups and early stage companies to obtain minority-business certifications required for local, state and federal government procurement set-asides
- Hosting an annual event focused on Black-owned tech businesses involved in geospatial and related technologies and applications

RECOMMENDED STRATEGIC IMPLEMENTATION APPROACH:

Entrepreneurial efforts by the STL GeoFutures Initiative would not be a stand-alone signature investment but would focus on two programmatic actions:

- **Ensuring a pool of matching funds for follow-on financing to foster the growth and scalability of new geospatial-related startups being generated, attracted and supported** through the STL GeoFutures Innovation Collaborative and ongoing efforts by the St. Louis entrepreneurial support system. This activity could become a component of the proposed STL GeoFutures Innovation Collaborative, which would have the staff capacity to qualify startup geospatial companies, or outsourced to qualified venture investment professionals by the STL GeoFutures Coalition.
- **Establishing entrepreneurial startup programming in collaboration with Black professional IT and engineering associations that would complement the growing efforts in Black entrepreneurship programs taking place in St. Louis.** This effort could be an enhancement of ongoing minority entrepreneurship efforts taking place in the region and would help build capacity within the Black professional associations.

Best Practice Example: Maryland Entrepreneurial Support Initiatives

The Maryland Technology Economic Development Corporation (TEDCO) now serves entrepreneurs from disinvested and underserved communities leading innovation-led companies through its Pre-Seed Builder Fund to provide both financial and operational support to address wide disparities in venture funding.

Key elements of the program include: a $50,000 pre-seed investment; a 12-week entrepreneurial training program on customer discovery, business canvass model and other lean start-up training; and access to coaching by a serial entrepreneur matched to the company.

Strategic Priority D: Support the Advancement of Community-led Neighborhood Development in North St. Louis

STRATEGIC NEED FOR ST. LOUIS

Perhaps the most challenging, yet inspiring, opportunity for STL GeoFutures is linking geospatial development with supporting a new inclusive approach to community-led neighborhood development. This linkage can lead to positive and sustained quality of life improvements and economic outcomes in the way of jobs, incomes and wealth creation for the residents of the disinvested neighborhoods of North St. Louis where the new 97-acre, $1.7 billion NGA West site will be located.

St. Louis has garnered national attention for its success in innovation-led placemaking, or what is often referred to as *innovation districts*. The Brookings Institution documented this emerging urban geography of innovation as "geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. They are also physically compact, transit-accessible, and technically-wired and offer mixed use housing, office, and retail."[29] According to Bruce Katz and Julie Wagner, who identified the rise of innovation districts back in 2014 while at The Brookings Institution, Cortex is now one of the best examples of an innovation district in the world, taking advantage of its proximity to major research institutions to leverage a creative mix of university talent, startup firms, mature companies and research labs.[30]

At the same time, T-REX, the city's downtown incubator, is growing by leaps and bounds, and is anchoring the innovation / start-ups district growing downtown. Most exciting for the STL GeoFutures Initiative is the focus by T-REX on becoming an innovation hub for geospatial development, with the launching of its geospatial innovation space, known as Geosaurus. This targeted geospatial development innovation space, catalyzed by major funding from Bayer, brings together entrepreneurs, established companies and partnerships with area universities and training providers. Plus, NGA has been attracted to the innovation complex that T-REX and Geosaurus offers, and is establishing its new software development lab along with siting innovation staff to collaborate and partner with innovative companies and talent.

Stakeholders hold both T-REX and Cortex in high regard for their ability to consolidate resources and offer high-value locations for entrepreneurial advancement in St. Louis. These stakeholders raised the need to continue to scale placemaking of St. Louis innovation hubs to complement Cortex and T-REX locations. Of particular importance to the stakeholders was focusing on a new innovation-led placemaking node that advances community redevelopment linked to geospatial development around the new NGA West North St. Louis site.

Yet other stakeholders actively involved in neighborhood development point to the challenges that must be overcome. The North St. Louis neighborhoods are among the most distressed areas in the City of St. Louis. There is a lack of civic infrastructure and capacity in the North St. Louis neighborhoods needed for leading community wealth-building activities. This reflects the high resident turnover and low levels of employment found in these North St. Louis neighborhoods.

In many ways, finding connections between equitable and inclusive neighborhood development and innovation districts is the unfinished agenda. Bruce Katz, Julie Wagner and Tom Osha observe in their update to the 2014 Brookings paper on innovation districts: "The interplay between innovation and inclusion … offers intriguing opportunities to be seized and serious threats to be averted. Innovation has the potential to be inclusive and enhance the living conditions and livelihoods of places and people without the downside consequences of displacement that many times accompany gentrification. Similarly, inclusion can be innovative, creating new ways of tackling traditional

29 *Bruce Katz and Julie Wagner, "The Rise of Innovation Districts: A New Geography of Innovation in America." (The Brookings Institution, May 2014).*
30 *IBID, page 27, "The Evolution of Innovation Districts: The New Geography of Global Innovation," The Global Institute on Innovation Districts, June 7, 2019, page 23*

problems via technological advancement and entrepreneurial dynamism."[31]

What is needed, according to Katz, Wagner and Osha, is the application of social innovation to innovation districts via both "inclusive innovation" involving creating pathways to labor market participation with specialized education and customized job training and wealth-building to expand ownership of homes and local businesses, as well as "innovative inclusion" to empower communities to solve problems in new ways using technologies to address civic engagement, health disparities, and other quality of life issues. In the case of North St. Louis neighborhoods, it is also critical to retain long-term owner occupied residents and not have them pushed out by taxes on rising property values.

ONGOING REGIONAL ACTIVITIES

There are a number of activities ongoing to engage the residents of the local neighborhoods of North St. Louis as well as to tackle the needed neighborhood development efforts to advance inclusion around the soon-to-be-completed NGA West site in North St. Louis.

One important effort with specific infrastructure development responsibilities is Project Connect, the City of St. Louis initiative to create alignment between the people, current and future plans and projects in the North St. Louis neighborhoods where the future site of the NGA West campus will be located. More specifically, Project Connect is responsible for ensuring the coordination and collaboration between neighborhood revitalization, transportation, and other redevelopment efforts and the City's investments to support NGA in eight North St. Louis neighborhoods: St. Louis Place, Old North St. Louis, JeffVanderLou, Carr Square, Columbus Square, Hyde Park, Downtown West and the North Riverfront. In 2016, Project Connect formed a Neighborhood Working Group (NWG) with 18 individuals identified by their neighbors as leaders in their community. This group met monthly with Project Connect and NGA representatives from August 2016 to March 2017 to discuss a variety of topics, concerns and community requests that were incorporated into an Action Plan and the NGA Construction RFP process. This group continues to meet to ensure residents have a voice in the many upcoming projects and plans in the area.

The 2017 Action Plan, which involved extensive community input to identify priority programs or projects where City investment might create the greatest community benefit, identified a number of important priority investments related to integrated stormwater management, transportation infrastructure investments and pedestrian and bicycle accommodations. Discussions around broader development opportunities that integrate with ongoing federal initiatives pointed to the importance of mixed use developments that build upon momentum of downtown and adjacent developments, and the need for neighborhood redevelopment to take advantage of the large area of vacant parcels for multifamily development, supporting retail and safer street crossings. It also set out keys to success that can help inform future developments:

- Focus public infrastructure into a defined subarea of the larger Project Connect area to provide a level of investment significant enough to catalyze private investment.
- Development should have a street presence that creates a sense of place unique to the neighborhoods and an address to attract private investment.
- The study area will require significant public investment to attract additional investors and development. In order to attract the market, it will be essential to change the perception of the area – both for investors and consumers. Both of these groups will need to be able to envision a future for the area.
- It will be important to start from the primary entry points of the NGA site to help change perception and to connect the development to the surrounding urban context. This will, in turn, help catalyze private investment in adjacent areas.
- Investment should start with the strengths of the site such as NGA and Choice Neighborhoods, and expand out from there.
- A variety of funding sources will need to be identified for public realm investment.

Great Rivers Greenway is a public agency connecting the St. Louis region with greenways to make the region a more vibrant place to live, work and pay. It was

31 IBID, page 27

established in 2000 by a public vote that also created a sales tax for GRG to collaborate with partners and communities to build out the network of greenways. It now has 125 miles built, and another almost 200 miles in planning. The Great Rivers Greenway has been actively involved in the planning of the Chouteau Greenway in the heart of the City of St. Louis. It is up to a 20 mile urban greenway that would knit together diverse neighborhoods and key cultural and recreational resources, including the neighborhoods of North St. Louis. The design concept is made up of a central loop in the middle of St. Louis, with links connecting to Forest Park, Fairground Park, Gateway Arch National Park, and Tower Grove Park. The extensive community planning focuses on each greenway segment responding to its particular neighborhood context. For the St. Louis Place segment that is close to the new NGA West site, the planning process noted the potential for pedestrian and bike mobility and linkages to cultural, civic, open space and everyday destinations. Among the recommended opportunities to build on the presence of local institutions, potential partners and multi-family residential developments, build multi-modal transit nodes with proposed MetroLink corridor and potential for a neighborhood commercial zoning district on the southwest corner of Cass Avenue and North Florissant.

Another organization becoming active in North St. Louis neighborhoods is Invest STL. Sponsored by the St. Louis Community Foundation, Invest STL is a regional initiative that aligns investment, technical assistance, and community organizations to build healthy neighborhoods. Invest STL is just beginning to engage with the North St. Louis neighborhoods and is focusing on capacity-building that can inform neighborhood planning and the identification of catalytic real estate investments. One opportunity being explored by Invest STL is to jump-start community engagement around the creation of a community space for businesses, job training and development services by redevelopment of light industrial building near 15th Street and Cass.

RECOMMENDED PROGRAMMATIC ACTIVITIES:

The STL GeoFutures Initiative is best positioned to play a supporting role to the ongoing community-led neighborhood development activities around the new NGA West, through continued efforts by Project Connect and recommended actions by the City's Equitable Growth Strategy that is just being completed.

The success of Project Connect to date is because of community, City, and regional coordination. As projects are further developed and implemented, this alignment is critical and continued coordination will be necessary to truly make a measurable impact on the Project Connect area. Project coordination should extend outside of the TWG to the Promise Zone, Choice Neighborhoods, Byrne Grant, local and national developers, and various neighborhood groups to ensure development and activities are focused to optimize the impact of public investment. It is recommended that SLDC engage the community and developers relative to findings from this Action Plan. Potential engagement opportunities include, but are not limited to:

- Establishment and management of a neighborhood-based, development review committee to identify community goals and specific requirements for inclusion in new redevelopment areas and/ or updates of current redevelopment areas/ agreements.
- Preparation of new redevelopment areas and/ or updates of current redevelopment areas/ agreements to align with community goals and Project Connect recommendations.
- Coordination of redevelopment projects and public improvements across a range of local, state, and federal agencies and departments with respect to community goals and Project Connect recommendations.
- Release of public Requests for Proposals to foster and solicit redevelopers - specifically for agency-owned properties and assets - within existing redevelopment areas in support of community goals and Project Connect recommendations.
- Collaboration with other city agencies and departments to update existing planning documents, tools, and regulations in support of community goals.

The City's Equitable Economic Development Framework incorporates both a physical development and neighborhood capacity building perspective in its guidance to support geospatial cluster development, including:

- Prioritize physical development and redevelopment surrounding N2W supporting off-site and spin-off activity around the N2W site to increase the potential geospatial-related economic upside, while also benefitting current residents living in and nearby the NGA district. Specific programmatic activities would include:
  - Identify potential (re)development parcels to support geospatial and other NGA-supporting firms within N2W and along the N2W/Downtown axis
  - Plan for and support commercial uses along Jefferson Avenue and on streets bordering the N2W site
  - Support the reuse of Pruitt Igoe for jobs-intensive development with the creation and release of a competitive RFP
  - Encourage new housing infill development around N2W

- Create strong connections between N2W, nearby neighborhoods and Downtown that promote strong linkages to employment districts:
  - Champion the N2W area for the initial build-out of the Chouteau Greenway with potential alignments along St. Louis, 20th and Cass to help integrate N2W into a larger network of connections. Jefferson is a critical opportunity to connect with the central core and is already proposed for street improvements and future transit service. In addition, clear connections along 20th Street and 14th Street (from Florissant) are necessary to provide clear connections to Downtown. These connections should include bike lanes and clear wayfinding but a shuttle should also be considered that provides regular connections between NGA, Downtown and Cortex.
  - Develop transit, a shuttle, bike lanes, and wayfinding to improve connections between NGA, Downtown, Cortex, Harris-Stowe State University and other key nodes

- Prioritize inclusive and equitable outcomes around the N2W project. Three areas of emphasis standout: 1) education and training that would link St. Louisans to direct and indirect jobs created in geospatial; 2) inclusive neighborhood transformation; and a 3) commitment from the outset of designing systems and measuring outcomes to ensure that all St. Louisans, including the city's African-American community, benefits from N2W.

From the STL GeoFutures stakeholder discussions, other specific program actions were identified:

- Leverage presence of new NGA unclassified building and its expanded software development lab, space for unclassified collaborations and possibly an accelerator. The program effort would provide complementary community investments to partner with NGA and create a link between commercial and national security geospatial solution development. This could include space for short term leases for industry collaborators, hosting accelerator companies, and hold hackathons, among other uses.
- Establish a Smart District Innovation Testbed – This would be a community-driven effort to identify a range of Smart City applications to benefit the quality of life of residents in North St. Louis neighborhoods from smart metering for energy conservation, home health care applications and skill training. To advance, it should have access to pilot funds to advance community ideas and develop small-scale demonstrations. It should also include a state-of-the-art learning laboratory for local residents focused on digital technologies.

RECOMMENDED STRATEGIC IMPLEMENTATION APPROACH:

Build around the continued efforts of Project Connect and in alignment with the soon-to-be-released City's Equitable Growth Framework. Future efforts in community-led neighborhood development will be a critical interface for the STL GeoFutures Initiative to have an active involvement in supporting a new inclusive community-led neighborhood development that leads to positive and sustained quality of life improvements and economic outcomes in the way of jobs, incomes and wealth creation for the residents of disinvested neighborhoods of North St. Louis surrounding the new 97-acre, $1.7 billion NGA West.

The type of community-led neighborhood development efforts needed, however, should not solely focus on

housing and commercial real estate development, but also address community capacity-building, skills development and entrepreneurship.

SUPPORT COMMUNITY-LED NEIGHBORHOOD DEVELOPMENT EFFORTS IN NORTH ST. LOUIS

Objective: STL GeoFutures would support community-led neighborhood development efforts in North St. Louis to advance social innovations to drive improved quality of life and community wealth-generation activities to grow incomes and assets of neighborhood residents by enhancing the skills, access to quality, entrepreneurship and home ownership.

Activities:

- Establish a community data set and provide data analytics to inform strategic thinking on improving North St. Louis neighborhoods, tracking a breadth of community-related data such as socioeconomic conditions, purchasing patterns, real estate and other quality of life measures
- Pursue healthcare delivery initiatives using geospatial tools to improve overall population health that address the comprehensive set of social determinants causing poor health outcomes among residents
- Identify opportunities for new community-based businesses
- Promote strategic neighborhood node developments for mixed developments
- Operate a N2W Area Community Smart City Innovation Testbed
- Connect local residents with nearby quality job opportunities involving skill upgrading
- Create financing tools and entrepreneurial training and mentoring services, in collaboration with citywide efforts, to serve local residents interested in starting and growing businesses

Governance:

- Community-led, independent non-profit organization

Operations:

- Involve entrepreneurs-in-residence to lead effort; require technical staff to oversee demo/testing center

Best Practice Example: University City District in Philadelphia

Formed in 1997, University City District (UCD) brings together neighborhood associations led by residents, anchor institutions and small businesses operating in the neighborhood, to focus on community revitalization. It focuses on a data-driven framework to invest in transforming public spaces, addressing crime and public safety, bringing life to commercial corridors, connecting low-income residents to careers and promoting small business formation and growth.

Among its accomplishments are:

- Spearheading successful public space projects, such as Market Street Bridge streetscape enhancements, the city's first parklet project, the Porch at 30th Street Station and Trolley Portal Gardens. Also created a nonprofit, full-service landscaping social venture to provide design-build-maintenance landscaping services for anchor institutions in the UCD, while employing community residents in good, stable jobs.
- Launching the West Philadelphia Skills Initiative to identify employer talent challenges and meet employer needs by recruiting, assessing, selecting, training and placing residents in career-ladder jobs that offer stable employment and advancement opportunities. Since 2011, 93 percent of its previously unemployed graduates have been connected to jobs with nearly 800 residents participating in its programs.
- Offering Project Rehab to restore distressed real estate, including identifying new property owners and guiding them through rehab process. Over 110 units brought back to market, helping owners access over $14 million in financing.
- Maintaining clean and safe streets with public safety ambassadors, patrolling streets in coordination with policy and institutional security forces, plus deploying a public space maintenance staff to clean 160 commercial and residential blocks and maintain 125 public trash cans.
- Promoting small businesses, many supporting improvements in commercial corridors in the UCD, to develop business plans, navigate zoning, find business locations and access funding. Many successful local businesses, such as Dock Street Brewery, Lee's Deli, Rosa's Fresh Pizza and Little Baby's Ice Cream, have been assisted

Strategic Priority E: Brand and Position St. Louis as a Global Thought Leader in Geospatial-Related Development

STRATEGIC NEED FOR ST. LOUIS

A region's reputation matters for innovation-led economic development. Whether related to ease of conducting business, quality of life, or status as a technology hub, reputation has implications for business and talent recruitment and retention, and ultimately the ability to successfully grow a technology cluster such as in geospatial development. Consistent themes arising out of interviews, site visits, and focus group meetings with regional business, university, and economic development leaders in St. Louis have centered around concerns regarding St. Louis' reputation as an overall inhibitor of its potential as an innovative tech hub. At the same time, many positive comments and themes were raised regarding the region's strong quality of life and affordability as place to live. There exists, however, a strategic need to address the challenges raised regarding regional reputation to ensure the ecosystem is optimal for geospatial sector development—specifically, a need to raise the awareness of St. Louis' position as an innovative technology hub and high-quality place to live and conduct business.

St. Louis is not viewed as a significant technology hub nationally. The region's leading, large companies are considered late adopters of technology, resulting in innovation challenges that ripple through the ecosystem. Despite recognition of a few clear innovation leaders such as Bayer and Enterprise, regional stakeholders see this as a limiting factor for generating innovation. Tapping larger geospatial-oriented businesses are a key means to boosting innovation regionally as they define market needs and provide the customer discovery and first customer adoption. The region needs more "champions" in its leading commercial sectors as early adopters of technology.

National or "outsider" perception of St. Louis is of an "uncool", even dangerous place to live. Despite the many positive comments on the region's quality of life and affordability, even from those new to the region, stakeholders consistently raised concerns regarding these perceptions regarding high levels of crime, a dysfunctional City/County divide, and a lack of "cool" amenities, all leading to talent and business recruitment and retention challenges. A number of stakeholders raise the 2014 shooting of Michael Brown and the resulting protests and unrest as a national view into the region's challenges regarding persistent, significant disparities in racial equity and in meeting the needs of distressed communities.

ONGOING REGIONAL ACTIVITIES

There are considerable efforts and broad engagement underway in St. Louis to position the region as a national leader in STL GeoFutures. Efforts have included:

- In 2019, AllianceSTL led a major St. Louis awareness and business recruitment effort at the global GEOINT Symposium under the banner "The Future of Geospatial is #STLMade." That effort was successful in creating a unified community message to the global industry that resulted in business recruitment leads now being managed by the AllianceSTL. Mayor Lyda Krewson delivered a nationally covered keynote address to the GEOINT Symposium about the growth of the geospatial industry in St. Louis.

- Going forward, St. Louis has been selected as the host city for the global GEOINT Symposium in 2023 and 2025, which will be the first time that St. Louis has hosted the Symposium.

- With the support from the St. Louis Development Corporation and the regional STLMade movement, there has been a concerted effort to elevate St. Louis' geospatial activities in local and national media. Examples of their collective work include coverage of the industry by ESPN in conjunction with that publication's coverage of the St. Louis Blues Stanley Cup championship; and a cover story in the St. Louis Business Journal about the TEConomy Partners baseline study, which highlighted "Geotech" as the next major industry opportunity in St. Louis.

FIGURE 28: RECENT NEWS HEADLINES TOUTING STRENGTHS OF ST. LOUIS AND ECOSYSTEM "WINS"

"Gates Foundation picks St. Louis as headquarters for new agriculture nonprofit"

"Cortex district brings in billions of dollars to the St. Louis area"

"St. Louis makes huge jump into ranking of top cities for entrepreneurs in US"

"Female Entrepreneurs Flourish In St. Louis, As Startups Increasingly Drive Economy"

"New St. Louis accelerator launches to support black, Latino founders"

St. Louis Named "One of the Fastest Growing and Top Ranked Emerging Life Sciences Markets in the U.S."

"NGA Breaks Ground On Nearly $2 Billion Western Headquarters In North St. Louis."

- GeoResolution, an inaugural thought-leadership conference hosted by St. Louis University with support from the Roundtable and the NGA, was launched in April 2019. The conference attracted over 600 attendees and participants in its first year, including: NGA Director Robert Sharp; now-Deputy Director of the NGA Stacey Dixon; university presidents Dwayne Smith and Fred Pestello; Google executive and Internet pioneer, Vint Cerf; World Wide Technology CEO, Jim Kavanaugh; and Esri founder, Jack Dangermond; among others.

PROGRAMMATIC ACTIVITIES & ACTIONS NEEDED:

The ongoing branding and marketing the St. Louis region in geospatial development has received strong community-wide support, and stakeholders urged it be sustained and amplified.

Establishing a brand requires both internal and external marketing. For internal audiences, it is important to deepen awareness and understanding of the potential for STL GeoFutures, the types of jobs found in the cluster and celebrating ongoing activities and industry developments. This requires a consistent presence in local news as well as accessible education programs targeted to specific audiences.

External marketing builds on the buzz created by the internal marketing activities, but requires more focus on being viewed as a global thought leader by being featured in national news reports, hosting national and international conferences and having an active social media presence.

RECOMMENDED STRATEGIC IMPLEMENTATION APPROACH:

Make branding and marketing a core activity of the ongoing STL GeoFutures Coalition, in coordination with broader regional economic development efforts, with the goal on establishing St. Louis as a global thought leader on STL GeoFutures. Among the specific activities needed are:

- Networking and leadership development to raise awareness and understanding of the potential for STL GeoFutures. This can include industry network events tied to the applications of geospatial technologies with national experts, immersion programs for educating business leaders, and community workshops tied to specific topics of interest.

- Earned media that build upon local stories and position St. Louis as a national leader in key story lines relating to geospatial development, such as how it is impacting key industries, driving equity and inclusion, upgrading talent and leading

innovations tied to the Fourth Industrial Revolution. Another approach on earned media is having the Coalition be home to resident experts that can generate white papers and drive social media on geospatial developments.

- Conference development and sponsorship are another way to raise the visibility of St. Louis as the go-to place on geospatial developments. These conferences should build on the leading industry sectors in St. Louis as well as focus on key audiences such as those involved in tech entrepreneurship, education and training and community development/Smart Cities, among others.

The Design for Implementation

The final element of the Strategic Roadmap for the STL GeoFutures Initiative is an implementation approach that is able to institutionalize broad community stakeholder engagement and collaboration building upon the mobilization achieved in the STL GeoFutures Initiative. The process of advancing the STL GeoFutures Initiative has engaged leaders from across industry, university, K-12 education, economic development and community-led organizations as one team for St. Louis in a way not seen since the Plant and Life Science Roadmap nearly 20 years ago.

This same spirit of cooperation and collaboration needs to be sustained if implementation of the STL GeoFutures Initiative Roadmap is to succeed. In particular, the action plan set out in the Roadmap is beyond the scope of any individual institution, so collaboration is key to success. Yet, it is well understood that collaboration among organizations, each with its own mission and activities, is not a natural phenomenon, but one that needs to be intentional and can only be maintained through careful attention to broad-based facilitation and engagement.

At the same time, the shared vision and action plan for the STL GeoFutures Initiative in its implementation must embrace and not displace the substantial efforts already underway to support geospatial development in St. Louis by individual institutions and organizations.

Best Practice Example: Milwaukee Water Council

The Water Council, since its founding in 2009, has served as to raise the profile of Milwaukee as an innovative leader in freshwater technology solving global water challenges. TWC serves as a non-profit, membership organization that connects, convenes and showcases the Milwaukee water hub comprising more than 200 water technology businesses as well as a network of 200 members from around the world. It has become a thought-leader in water innovation through its annual Water Summit; a global directory; advancement of an Energy-Water Nexus Roadmap with first-of-its-kind compilation of data and intelligence on technology needs, target markets and companies active; innovation efforts including an accelerator, customer matching program, in-field testing of water technologies and sponsoring a globally-based Tech Challenge. It also has the capability to host overseas companies looking for US collaborators and locations at its Global Water Center, home to The Water Council and the North American headquarters of the Alliance for Water Stewardship (AWS) and over 40 water-centric businesses, startups and academic and research organizations.

As set out in each of the strategic priorities, there are many ongoing and emerging organizational efforts underway in the St. Louis region that are focused on supporting geospatial development involving a wide range of activities such as:

- University R&D Centers
- Education & Workforce Development
- Entrepreneurial Development
- Placemaking/Innovation Hubs
- Marketing

Unlike the situation faced 20 years ago when the Plant and Life Sciences Roadmap was conceived, there is a far more advanced set of development resources in place which the STL GeoFutures Initiative can tap and, most importantly, are already seeking to seize upon the opportunity for geospatial development. So, where the Plant and Life Science Roadmap faced a largely "start-up" cluster effort and had to catalyze the formation of many development resources in the ecosystem to

fully realize the region's potential, the STL GeoFutures Initiative is more of a "scale-up" cluster effort that needs to link, align, and enhance efforts. In this regard, the STL GeoFutures Initiative is benefitting from the success of the Plant and Life Sciences Roadmap to foster and nurture an innovation ecosystem in the St. Louis region.

Designing the implementation of this scale-up cluster effort for the STL GeoFutures Initiative faces a key question: how to enhance activities of the many existing and emerging development resources and activities that are mobilizing to address the needs for geospatial development, and yet not simply become a collection of narrow program activities, but a collaborative effort with a shared vision that addresses strategic opportunities and gaps in a coordinated and robust manner over time?

The answer is establishing a STL GeoFutures Coalition, as the lead signature initiative to oversee the Roadmap implementation and ensure a sustained commitment to transformative, inclusive and equitable growth across all Roadmap activities.

THE STL GEOFUTURES COALITION – A CATALYTIC STEERING, INVESTING, CONVENING AND LEADERSHIP DEVELOPMENT ORGANIZATION

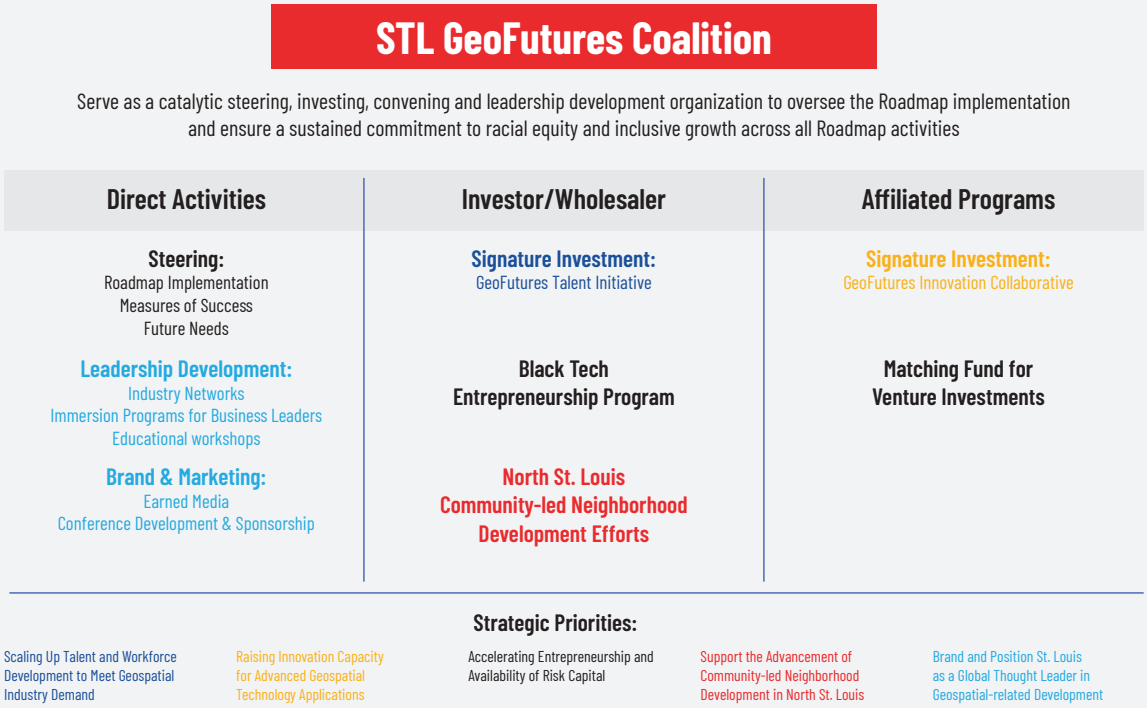
As the lead signature initiative, the STL GeoFutures Coalition will serve as the "cluster hub" for geospatial development in St. Louis. According to The Brookings Institution, a cluster hub serves as the: "driver of the cluster, pushing the local economy towards a shared vision, acting as a thought leader and convener, coordinating existing assets, ensuring a collaborative environment, managing its own programs and initiatives to fill important gaps in the system, and strengthening and championing the case for the cluster locally and in targeted markets."[32]

The STL GeoFutures Coalition would be responsible for raising funds and overseeing the implementation of the Strategic Roadmap. It would largely function as a steering and investing organization that engages and convenes the full community and seeks to enhance and leverage the capacities of existing and emerging resources and organizations to accomplish the vision of the Strategic Roadmap with strong emphasis on accountability in achieving results that are inclusive and equitable. Still, the STL GeoFutures Coalition would play a direct role in a number of critical functions beyond steering and investing, including being the lead on the strategic priority to brand and position St. Louis as a global thought leader in geospatial development, as well as having a role in supporting career connections across industry, educational institutions, workforce training providers, students, and job seekers.

Figure 29 sets out the different roles that the STL GeoFutures Coalition would play across strategic priorities and actions. Beyond the direct activities of the Coalition, it would be an investor that solicits and contracts for services from education and workforce providers for the STL GeoFutures Talent Initiative, industry associations and entrepreneurial development groups for the Entrepreneurship Program for Black Tech Professionals and from North St. Louis neighborhood organizations for community wealth creation and Smart City applications to benefit local residents. The STL GeoFutures Coalition will also help establish and fund the STL GeoFutures Innovation Collaborative as an industry-led organization as well as seek private sector management for the Matching Fund for Venture Investments in geospatial-related companies, so these are considered more affiliated, though separately operated, activities of the Coalition.

32 Donahue et. al., Rethinking Cluster Initiatives, The Brookings Institution, July 2018, page 31.

FIGURE 29: OVERVIEW OF THE IMPLEMENTATION OF STRATEGIC PRIORITIES AND ACTIONS UNDER THE STL GEOFUTURES COALITION



The full set of activities for the STL GeoFutures Coalition are:

- Overseeing and monitoring the Roadmap's implementation, measures of success and future needs for advancing STL GeoFutures development.

- Convening leadership from across industry, universities, government, and disinvested communities, and pursuing collaborations for public-private and multi-sector partnerships needed to fund and stand up signature initiatives and pursue other actions set out in the Strategic Roadmap.

- Serving as an investor and "wholesale" contracting organization that seeks to scale-up and enhance ongoing efforts that are working and engage organizations to undertake additional needed program activities in support of the STL GeoFutures Roadmap.

- Positioning St. Louis as a global thought leader in geospatial development through: branding and marketing activities, in coordination with regional economic development efforts, including earned media highlighting stories on St. Louis successes and activities; networking and leadership development, including hosting various speakers programs and workshops, supporting industry network groups on geospatial applications, and establishing a fellows program to immerse business and community leaders in the value of locational data to their organizations; and, conference development and sponsorship to raise the visibility of St. Louis as the go-to place on geospatial developments.

- Establishing a capacity for career connections that aggregates industry needs and requirements, offers a job posting board and facilitates matching interns and recent graduates with employers.

The governance of the STL GeoFutures Coalition would be similar to how the Advisory Committee for the STL GeoFutures Initiative was formed. It would seek broad representation from leaders of geospatial-related industry, universities, government, economic and workforce development and civic organizations

Best Practice Example: Nashville Health Care Council

Formed in 1995, the Nashville Health Care Council has become the premier membership association for health care leaders. It convene's the industry's top minds and has provided a foundation for collaboration in health care. Through its educational programs, networking and mentoring activities, the Council is able to serve health care executives with timely information on key operational and policy issues.

One of its signature programs is the Nashville Health Care Council Fellows, an initiative designed to engage, educate and foster the next generation of health care leaders. It involves a five-month intensive program to help emerging health care leaders better implement business strategies, create value, and drive industry growth and effect change. Among its activities are six full-day sessions and two retreats with top health care leaders, a 360-degree view of the front lines of health care and unique immersion experiences.

Another forward-looking effort is the Council's Leadership Health Care that offers educational events and networking opportunities to individual health care professionals.

Ultimately the full value of the Council has been to create a dynamic and supportive operating environment for existing, start-up and relocating health care businesses, able to attract top talent and connect the Nashville health care community with leading global thinkers and doers in health care.

and community-based racial equity and inclusion organizations.

In its operations, the STL GeoFutures Coalition will involve a lean staff model with capabilities in strategic planning, communications and marketing, and management of contracts with a network of providers. Other cluster hub organizations have similar lean staff models. For example, the Nashville Healthcare Council has a full-time staff of 12 and the Milwaukee Water Council has a staff of 13.

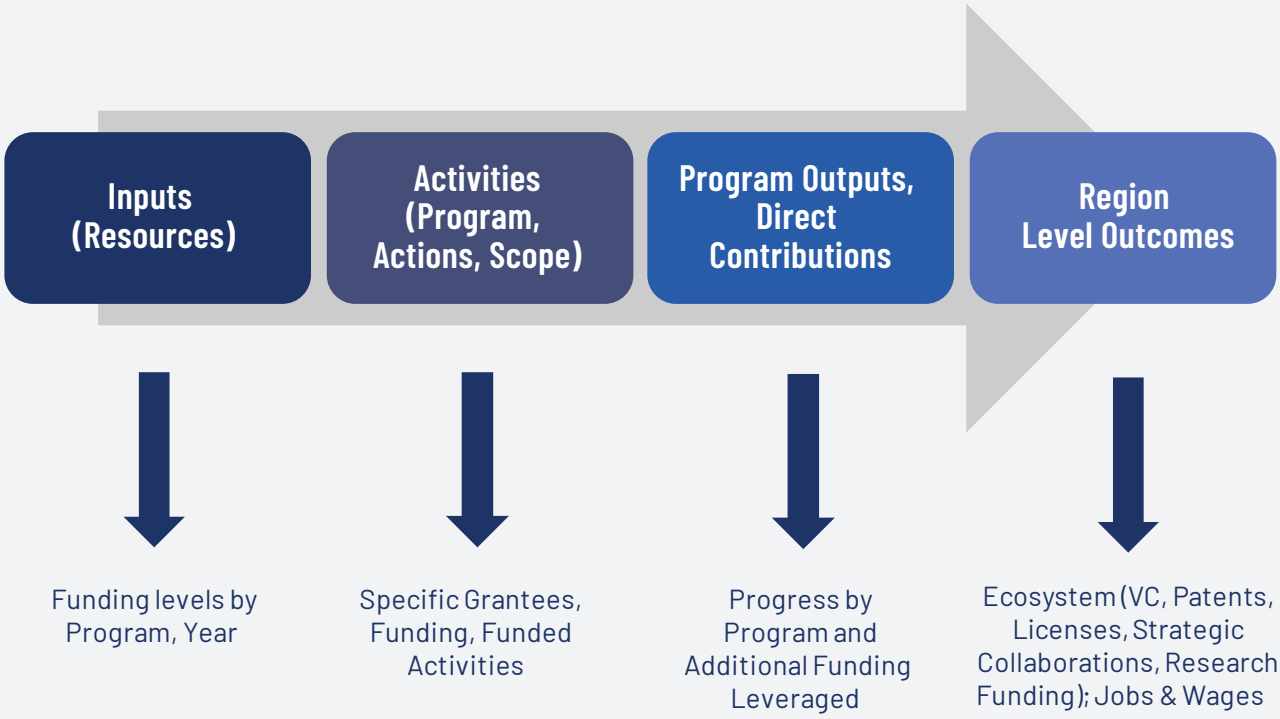
PERFORMANCE MEASUREMENT OF THE STRATEGIC ROADMAP

One of the most important roles of the STL GeoFutures Coalition, as indicated above, will be to oversee and monitor the Strategic Roadmap's implementation, which includes identifying and tracking performance across measures of success.

A very standard and accepted approach to considering performance measures for a complex and comprehensive cluster development effort is through the use of a "logic model" to represent program operations and outcomes. The logic model is widely used as a tool in assessing the implementation of a newly formed initiative by modeling how a program is intended to work (the "logic" of the initiative) and allowing for measures along the way to ensure that each step is occurring as planned. As the Kellogg Foundation explains in its Logic Model Development Guide, "the purpose of a logic model is to provide stakeholders with a road map describing the sequence of related events connecting the need for the planned program with the program's desired results."[33] Figure 31 captures the key components that go into a logic model across inputs, activities, outputs and outcomes.

33 W.K. Kellogg Foundation Logic Model Development Guide, January 2004, page 3, available at www.wkkf.org.

FIGURE 30: KEY COMPONENTS OF THE LOGIC MODEL FOR TRACKING PROGRESS AND PERFORMANCE OF NEW INITIATIVES OVER TIME



For the STL GeoFutures Initiative's Strategic Roadmap, it will be of particular importance to track who actually benefits from the signature initiatives and other actions undertaken. This needs to be considered from both a focus on outputs or who is participating in receiving services from program, activities, as well as on outcomes or what are the results across population groups. Table 7 sets out specific output and outcome measures across the five strategic priorities to help think through overall performance measurement for the GeoFutures Strategic Roadmap.

TABLE 7: RECOMMENDED PERFORMANCE MEASURES FOR TRACKING SUCCESS OF THE STL GEOFUTURES ROADMAP ACROSS STRATEGIC PRIORITIES

Strategic Priority	Output Measures	Outcome Measures
Scale Up Talent and Workforce Development to Meet Geospatial Industry Demand	• Number of participants in educational and training programs supported tracked by race, ethnicity, gender and place of residence	• Certifications and Degrees Awarded by race, ethnicity, gender and place of residence • Job placements of participants by race, ethnicity, gender and place of residence
Raise Innovation Capacity for Advanced Geospatial Technology Applications for Leading Industry and Community Development Drivers	• Faculty recruited by race, ethnicity, gender and place of residence • Number of companies participating in applied research/innovation project efforts • Recipients of proof-of-concept funding by race, ethnicity, gender and place of residence • Number of participants in activities, such as hack-a-thons, student design projects, community Smart City pilots, etc. by race, ethnicity, gender and place of residence	• Research funding generated by faculty recruited by race, ethnicity and gender • Leveraged funding from federal and private sources, such as SBIR/STTR awards and follow-on angel, seed and formal venture capital, generated from proof-of-concept projects tracking entrepreneurs by race, ethnicity, gender and place of residence • New products advanced, including patents awarded, sales generated • New geospatial-related companies formed tracking entrepreneurs by race, ethnicity, gender and place of residence
Accelerate Entrepreneurship and Availability of Risk Capital	• Participants in entrepreneurship programs supported by race, ethnicity, gender and place of residence • Companies invested in tracking entrepreneurs by race, ethnicity, gender and place of residence	• New geospatial-related companies formed tracking entrepreneurs by race, ethnicity, gender and place of residence • Leveraged funding generated in geospatial-related companies tracking entrepreneurs by race, ethnicity, gender and place of residence
Community-led Neighborhood Development in North St. Louis	• Number of North St. Louis residents participating in community wealth building projects (job training, entrepreneurship and home ownership) by race, ethnicity, gender • Number of North St. Louis residents participating in Smart City applications	• New businesses launched through community wealth building tracking jobs generated and sales generated • New home ownership by North St. Louis residents • North St. Louis residents in job training hired for jobs in field of training
Brand and Position St. Louis as a Global Thought Leader in Geospatial-related Development	• Number of conferences, workshops, industry network events • Participants in leadership development programs and industry networking by race, ethnicity, gender and place of residence	• National stories on STL GeoFutures • Out of state participants in conferences and workshops held in St. Louis

Beyond the performance measures of specific program activities across each strategic priority, it will be important to track on an annual basis the overall position of St. Louis in geospatial development. This would involve replicating the benchmarking analysis as well as tracking racial and ethnic participation in all geospatial-related activities in degrees, jobs and self-employment on at least a biennial if not annual basis.

Across the breadth of the innovation ecosystem, the specific benchmark measures to be tracked include:

Geospatial Workforce
- Job openings
- Occupational employment by race, ethnicity and gender

Geospatial-related University Education & Research
- Degree graduates
- R&D expenditures

Geospatial Tech Development
- Patents
- SBIR/STTR awards

Geospatial Entrepreneurial Development and Risk Capital
- Self-employment in geospatial-related industries by race, ethnicity and gender
- Number of new early-stage venture capital-backed startups (pre-seed, angel investor and seed) by race, ethnicity and gender of founders
- Venture Capital investments by race, ethnicity and gender of founders
- Follow-on investments after early-stage funding by race, ethnicity and gender of founders

This comprehensive approach to performance measurement will enable the STL GeoFutures Coalition to effectively demonstrate how geospatial development is advancing and the effectiveness of its program activities aligned with the focus on inclusive and equitable growth. It will also allow the STL GeoFutures Coalition to become a leading source of intelligence on geospatial development around the nation.

GEOFUTURES

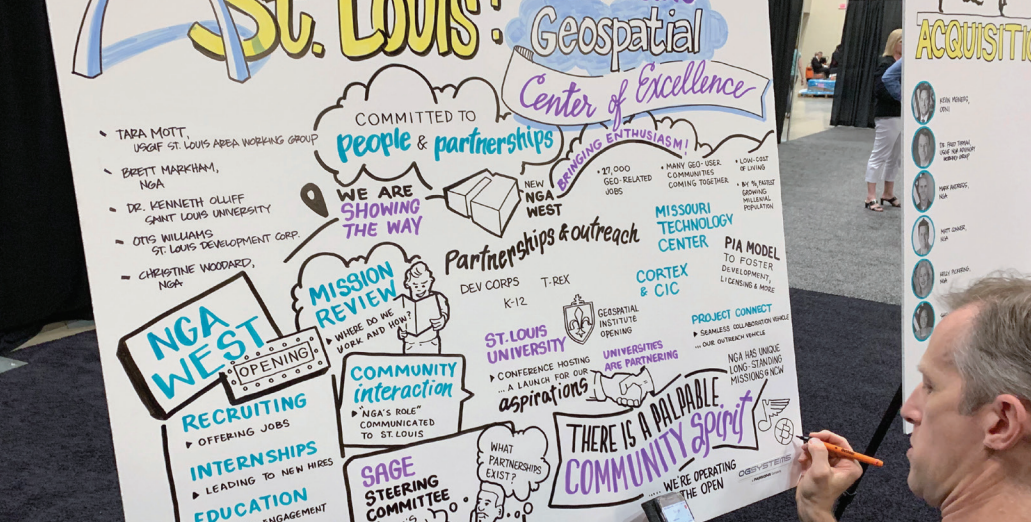
LOOKING AHEAD

Looking Ahead

St. Louis has had a long and rich history with geospatial development, but never an intentional one focused on making it a regional innovation and growth driver. This Strategic Roadmap set out by the STL GeoFutures Initiative represents the first time St. Louis has put in place a framework to link, align and enhance the capabilities of the region's innovation ecosystem to fully realize the transformative, inclusive and equitable growth driver that geospatial development represents for the region. But it will take patience to put all of the pieces in place to initiate and advance the recommended signature initiatives and focused action steps to bring this Strategic Roadmap fully to life.

In the weeks ahead, the imperative is to institutionalize the strong level of community engagement and collaboration into a formal STL GeoFutures Coalition to serve as the cluster hub for geospatial development. Through the Coalition, it is expected that St. Louis can mobilize and sustain the public and private support and engagement to use this Strategic Roadmap as the framework for implementation.

This Strategic Roadmap represents, then, a critical starting point. As investments are made and the recommended signature initiatives and focus program activities are implemented, this Strategic Roadmap will need to be refined as an operating plan for progress by the Coalition. It is an effort worthy of the journey ahead.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THE WAY
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& CIC
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THE FUTURE OF GEOSPATIAL IS
STLMADE

JIM
EXHIBITOR
STLMADE

THE FUTURE OF GEOSPATIAL IS
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Ryan Helwig
Mitchell Horowitz
Hon. Letitia "Tish" Long, former Director, NGA
Sam Murphey
Tracy Whelpley
Tony Wyche

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