DIA Case Study Appendices

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Appendix A: Strategic Pillars, City Alignment, and Citizen Benefit

DIA Pillar	Topic Area	Upcoming & Existing Projects in West End Living Lab	Value to Citizen	City Priority Supported	Dallas 365	Smart Dallas Priority Supported	Benefit for City of Dallas	City & External Partners Engaged
Resource Efficiency	Energy	LED & Connected Street Lighting	• Improved lighting quality and safety [both perceptual and actual] • Quicker repair of light outages • Funds Saved can be allocated to other citizen-centric areas and services	• Sustainability • Government Efficiency • Innovation/Smart Cities • Safe Neighborhoods	• Resource Conservation/ Sustainability • Improved Infrastructure • Intelligent Emergency Response • Thoroughfare street lights functioning • Quality of Life: 311 Report Response Time • Government Performance & Financial Management	• Smart Energy + Environment • Smart Public Health + Safety	• Energy efficiency toward sustainability metrics • Cost savings in energy and operational efficiencies • Improved public safety via improved lighting • Upgrading infrastructure to allow for additional functions for poles [crowd, noise, gunshot detection sensors; small cell and Wi-Fi encasement; cameras]	• City: Communication & Information Services, Mobility & Street Services, Sustainable Building & Construction /Real Estate, Historic Preservation, Landmark Commission • External: Oncor, Downtown Dallas Inc., West End Association, DART, Philips and GE
	Water	• Automated Metering Infrastructure (AMI) • Smart Irrigation Systems	• Greater insight into water usage and cost; opportunity for behavior change to impact both of these elements. • Minimizing repair scope and construction that impacts roads and commute times.	• Sustainability • Government Efficiency • Improved Service Delivery	• Resource Conservation/ Sustainability • Water Meter Reading Accuracy • Quality of Life: 311 Report Response Time • Government Performance & Financial Management	Smart Energy + Environment	• Water conservation contributes toward sustainability metrics • Cost savings in water [conservation, leak detection] and operational efficiencies eliminating manual meter reading and late notification of repair needs. • Service delivery/ consumer transparency around advanced metering/usage visibility	• City: Communication & Information Services, Dallas Water Utilities, Parks & Recreation, Cultural Facilities, Office of Environmental Quality • External: Itron and HydroPoint Data Systems
Public Health	Public Health & Environment	Environmental sensor kit measuring six different factors: Temp, humidity, CO2, NO2, Ozone and Particulate Matter/Allergens	Information on areas of air quality that impact and exascerbate conditions include asthma and allergies	• Public Health • Sustainability	• Localized Environmental Quality Visibility • Data-Driven Governance • Intelligent Insights & Congestion Reduction	• Smart Energy + Environment • Smart Public Health + Safety	• Enhanced air and environmental data, especially around particulate matter & public health impacts. • Provide public awareness around "hot spot" days for asthma, allergies and overall air quality. • Awareness and treatment lead to less school and job absences and improved performance. • Leverage in related OEQ & resiliency efforts.	• City: Communicatio & Information Services, Office of Environmental Quality, Resiliency • External: Downtown Dallas Inc., DCCCD, DISD, University STEM programs regionally, Ericsson.
	Green Space	Providing insight into the design and development of West End Square, one of the four priority downtown parks being built by the City of Dallas Parks & Recreation Department and Parks for Downtown Dallas	• Mental and Physical Health benefits of outdoor activity • Reduced heat island impacts • Enhanced public space for rest, play and interaction	• Public Health • Sustainability	• Quality of Life • Human and Social Needs • Economic and Neighborhood Vitality • Resource Conservation/ Sustainability	• Smart Energy + Environment • Smart Public Health + Safety	Contributions to public health, sustainability and quality of life priorities. Green space brings associated economic impact and attraction. "Smart" elements to the park design improves operational and cost efficiencies in park management.	• City: Parks & Recreation, Communication & Information Services • External: Parks for Downtown Dallas, West End Association, Downtown Dallas Inc.

DIA Pillar	Topic Area	Upcoming & Existing Projects in West End Living Lab	Value to Citizen	City Priority Supported	Dallas 365	Smart Dallas Priority Supported	Benefit for City of Dallas	City & External Partners Engaged
Citizen Engagement & Service Delivery	Citizen Engagement & Service Delivery	Digital interactive kiosk with USB charging ports and customized software including wayfinding, public buildings & services, points of interest, public education campaigns, etc.	• Localized access to information guiding transit and travel, city facilities and services, and local amenities. • Added potential to have direct interaction with City staff via webcasts, 311 reporting; potential to pay water bills and other transactions; Wi-Fi hotspots/ access & others.	• Citizen Engagement • Service and Information Delivery	• On-Demand Access • Multimodal Transit • Government Performance and Financial Management • Human and Social Needs • Community Engagementent	Smart Governance + Community	• Revenue streams via digital advertising and small cell/5G leasing is possible • Additional functions for public safety, connectivity, etc. • Create an offering for citizens as a gateway to introduce smart cities technology that will allow the city to offer connectivity between citizens and the city. • Test new methods for installing, housing and scaling connectivity across Dallas. • Additional revenue streams via licensing or advertising.	• City: CIS, Mobility & Street Services, Sustainable Building & Construction/Real Estate, Historic Preservation, Landmark Commission • External: Oncor, Downtown Dallas Inc., VisitDallas, West End Association, DART, CIVIQ Smartscapes
	Connectivity	• Public Wi-Fi [City of Dallas initiative] • Small Cell/WI-FI/5G encasement [Potential future project] • Digital Divide: Underserved community broadband/ Wi-Fi access [Project in development for Phase II in Southern Dallas neighborhoods]	Access to internet and cellular connectivity for residents and visitors to Dallas	• Innovation/Smart Cities • Technology/ Infrastructure • Talent Attraction • Economic Development • Equity • Poverty	• On-Demand Access • Improved Infrastructure • Community Engagements	Smart Public Health + Safety	Providing connectivity in key areas in downtown to further engage our citizens in their need for constant connectivity	• City: CIS, Mobility & Street Services, Sustainable Building & Construction/Real Estate • External: Oncor, Downtown Dallas Inc., West End Association, DART, AT&T
	Data Analytics & Transparency	Interactive Data Dashboard and Visualization: Providing data captured from the Living Lab in an interactive online dashboard allowing for easy exploration of data, and ability to export raw data.	• Researchers, Teachers and Students: access to project data for use in research and STEM curriculum. • Entrepreneurs: Access to project data for use in building, developing and testing new products/services. • Public: Easy to understand visualization of impacts of projects and data; expands data literact. • Data transparency	• Innovation/Smart Cities • Technology/ Infrastructure • Talent Attraction • Economic Development	• Data-Driven Governance • Intelligent Insights • Government Performance and Financial Management • Community Engagements	Smart Governance + Community	Data analytics bring insights and efficiencies not possible with manual processes; these insights allow city management to be proactive rather than reactive in maintenance, operations, public safety and data-driven decisionmaking.	• City: Communication & Information Services • External: Amazech
Mobility	Mobility	• Smart Parking pilot • First mile/Last mile project in development for Phase II • Emergency service delivery project in development for Phase II	• Ease of locating available parking • Improved air quality/ CO2 related to decreased circling/ idling finding parking • Land use/planning changes could result from parking usage data, creating increasingly pedestrian-friendly environments.	Technology/ Infrastructure	• Data-Driven Governance • Intelligent Insights & Congestion Reduction • Commuter Safety • Improved Infrastructure	• Smart Transportation + Mobility • Smart Public Health + Safety	• Better visibility of parking lot/on street spot utilization and capacity; make more informed land use decisions • Potential to increase parking revenue via demand pricing or enforcement automation • Improved multi-modal service and options for all Dallasites	• City: CIS, DPD-Parking, MSS • External: DART, Downtown Dallas Inc., West End Association, Real Estate Owners, Residents, ParkHub, AT&T Digital Infrastructure
Neighborhood Revitalization/ Economic Development	Neighborhood Revitalization/ Economic Development	• Pedestrian Counting Beacon Technology • Improved LED Streetlighting • Small business revenue reporting	• Increased amenities in neighborhood via business mix, attraction • Job creation • Increased pedestrian traffic • Improved public safety • Small business success and longevity	• Talent Attraction • Economic Development	• Data-Driven Governance • Commuter Safety • Resource Conservation • Improved Infrastructure • Intelligent Emergency Response • Intelligent Insights & Congestion Reduction • Multimodal Transit	• Smart Governance + Community • Smart Transportation + Mobility	• Improved occupancy rates, tax base, business and job creation • Increased community 'ownership' and investment in neighborhood • Improved public safety	• City: CIS, Real Estate, Economic Development, Landmark Commission, Streets Public Works • External: Downtown Dallas Inc., DART, West End Association, Dallas Regional Chamber, EBSystems, Current by GE, Philips

Appendix B: DIA Member Organizations

Appendix C: City of Dallas Departments Engaged

Office of Mayor Michael S. Rawlings

- Michael S. Rawlings, Mayor
- Vana Hammond, Chief of Community Relations & GrowSouth
- Scott Goldstein, Chief of Policy & Communications
- Brenda Allen, Community Relations Coordinator

City Council

City Manager's Office

- T.C. Broadnax, City Manager
- Majed Al-Ghafry, Assistant City Manager
- Jon Fortune, Assistant City Manager
- Joey Zapata, Assistant City Manager
- Theresa O'Donnell, Chief Resiliency Officer
- Raquel Favela, Chief of Economic Development and Neighborhood Services
- Bill Finch, Chief Information Officer

Communication and Information Services (CIS)

City Attorney's Office

Dallas Police Department (DPD)

Dallas Water Utilities (DWU)

Economic Development

Equipment & Building Services (EBS)

Landmark Commission and Historic Preservation

Transportation

Mobility & Street Services

Office of Environmental Quality (OEQ)

Parks & Recreation

Planning

Public Works

Sustainable Development & Construction

Sanitation

Appendix D: Sample Community Organizations Engaged

Better Block
bcWORKSHOP
Big Thought
Circle of Support
CitySquare
Commit! Partnership
Dallas Arts District
Dallas County Community College District
Dallas County Community College District STEM Institute
Dallas Holocaust Museum
Dallas Housing Authority
Dallas Independent School District
Dallas Residents Council
Deep Ellum Foundation
Green Careers Dallas
Innercity Community Development Center
Illuminate STEM
NAF Academy at Justin F. Kimball High School
Parks for Downtown Dallas
Positive Breathing Organization
Revitalize South Dallas Coalition
Southern Dallas Link
Southern Methodist University
State Fair of Texas
St. Philips Schools & Community Center
TalkSTEM
T.R. Hoover Community Development
The Trust for Public Land
The University of North Texas
The University of North Texas School of Public Health
The University of Texas at Arlington
The University of Texas at Dallas
West End Association

Appendix E: Issue Briefs

Civic Data Ownership & Monetization

Civic data is an asset with a tremendous potential for value. Consider that across the United States, whenever a citizen calls 311, registers for a permit, or utilizes city services, they create public data; additionally, as more public infrastructure gets connected, each piece of infrastructure produces new data, ranging from water levels and pollution readings to deep insights into how citizens interact with infrastructure. The potential value of civic data grows daily, but cities often operate under an assumption that the data they collect and publish should always be available at no cost. Certainly, taxpayers have a right to access the data that they are funding, and there is a solid case that public data to be unconditionally free to nonprofits, the press, or academic researchers, but should businesses that utilize this data for a profit also be afforded free access?

In the private sphere, the "everything is free" model has ceded ground to the "freemium" model – apps now provide limited versions pushing users to pay more for additional features. Consumers broadly accept paywalls for news media, purchase digital copies of songs, are willing to sit through YouTube ads[1]. Selling data is nothing new; third-party data brokers have operated for decades, collecting data otherwise unavailable and making them available to anyone willing and able to pay. Therefore, by adopting a "data marketplace" approach, wherein cities charge a subset of users for access to civic data, cities can fund premium data services and perhaps spur innovation. Certainly, there are policy implications to combining private and public data in marketplaces; the ownership and liabilities of combined data could be quite complex[2]. In spite of the challenges in doing so, opening data to the public redeploys these assets in ways that encourage transparency of course, but importantly, also entrepreneurialism and innovation outside the four corners of city hall, and by charging users for premium services, cities can better afford to improve the overall quality of available data[3].

An early mover in this field is the city of Copenhagen, Denmark, which since 2015 has partnered with Hitachi to operate the City Data Exchange, a software-as-a-service platform wherein raw data from the city and its vendor partners are made available to customers that pay subscription and service fees. Initial results from this project suggest that, although there are still kinks to work out, a monetization platform can successfully overcome regulatory and privacy concerns[4]. Even without a major corporate partner controlling database access, software already exists to control who accesses how much data, and access can be designed a number of ways. For example, cities can charge users based on the volume of data consumed, so that only high-volume users pay anything. Alternatively, cities can give users a time-limited level of free access, or waive fees for NGOs, press, and citizens. Possibilities for a "quid pro quo" system with private-sector partners also exist, wherein companies are given access to civic data in exchange for access to their internal data[5]. Similarly, data access is beginning to be incorporated in contractual negotiations to defray project costs.

Recommendations

Early insights from Copenhagen[6], as well as an ongoing debate about data monetization in Canada[7] have yielded a number of common insights and recommendations for cities considering civic data monetization:

- Establish well-defined use cases based on specific business opportunities and challenges, that include both consumer- and supplier perspective, and are clear on avoiding risks and pitfalls.
- Encourage and support the creation of a regional data community where stakeholders can meet and explore opportunities, link to other activities and data sources, and identify data demand patterns across sectors.
- Enforce common standards for data sharing, especially as the market matures and more companies look for guidance on both finding new data and identifying customers for data that they produce.
- Ensure that data portals have simple interfaces and user-friendly designs for understanding data, and that accessibility and usability changes are reflective of the datasets and features most frequently used.
- Enable users to tie together related datasets, either during data discovery or via APIs.
- Set clear, transparent pricing based on the size of datasets being accessed or downloaded, rather than by the number of datasets.
- Enact policies and procedures that mandate public sector data ownership and open architecture, to ensure that the value of data profits citizens rather than corporations and that the public good remains paramount.

Data Management, Standardization, Analytics

Today's digital transformation provides cities with ever-increasing ways to capture data, but many cities fall short of their digital potential because they focus on collecting and using data in narrow, traditional ways. Further, simply publishing data is no longer enough; city leaders must choose data formats that help citizens understand those data, while providing background on how the data are created, the organizational structure of the data, and how the data are intended to be used, so that citizens will be more willing to trust the data as reliable and relevant to their needs. They must also be willing to combine and analyze the data in novel ways, to become more proactive in assessing city priorities while problems are at sub-critical levels, rather than constantly finding themselves stuck reacting to citizen complaints. The transition from reactive to proactive/predictive is the key to improving internal operations and citizen service delivery.

A coordinated data management strategy benefits both citizens and decision-makers in (at least) four ways. First, through the resulting economies of scale and synergies, a variety of stakeholders can more easily share resources and expertise, and may be better able to collaborate when pursuing opportunities. Second, city leaders gain a competitive advantage on grant opportunities that require data management plans for successful proposals - a requirement that will only continue to rise in prevalence. Third, by making it easier for stakeholders to consume, combine, and compare data from multiple departments, city leaders jumpstart innovative data usage[8]. Finally, the burden of preserving data and access across the data life cycle is eased, especially as data are used- and reused for different projects[9]. As an example of the benefits of a coordinated data management strategy, Chicago has implemented a "dig once" policy, where projects across departments (e.g. water repairs, fiber installation) are coordinated in a way that allows for a single street cut. This level of coordination, while valuable, requires data integration and analytics, but results in increased citizen satisfaction and reduced lane closures and maintenance-related frustrations.

Developing, implementing, evaluating, and modifying a data management strategy calls for dedicated staff members who possess a deep understanding of the technical, structural, and semantic aspects of data. Additionally, they must be able to consider the data from the viewpoints of multiple stakeholders, set priorities for data publication, ensure that the data are available in a reasonable number of formats on open data portals, and enforce data interoperability among departments that provide data[10, 11]. Producing and managing standardized data published to an open portal are essential, but a truly smart city goes beyond those tasks - probing deeply into data to solve for the problems of both citizens and businesses, increase efficiency, and identify new opportunities. As an example, while quality data can create a map of traffic accidents to guide infrastructure projects, analytics combines these incidents with time of day, weather patterns, roadway surfaces and conditions, and so forth, to explain why these accidents are occurring, and suggest location-specific solutions. While dedicated data analysts (either within departments or working alongside data managers) can effectively generate-, test, and operationalize a variety of data analysis methods, startups and public-private partnerships are also viable partners in this realm, especially in cities with limited resources and strict hiring restrictions[12]. Additionally, participation in University-driven city consortiums such as the Harvard Ash School allow for peer-to-peer insights that can expedite progress and minimize missteps.

Recommendations

Literature recommends that any policies regarding data management, standardization, and analytics address the following five categories[13, 14]

- Types of data, physical collections, software, and other produced materials
- Standards for data and metadata format and content
- Access and sharing policies
    - Consider issues of, *inter alia*, privacy, confidentiality, security, intellectual property
- Policies and provisions for reuse and redistribution
- Data archiving and preservation

Data Privacy Policies

Throughout much of the developed world, privacy is considered a right, and is protected by law. However, people's behavior is now being recorded more often, and in a wider variety of ways than ever before, and the escalation of security breaches involving sensitive data and personally identifiable information has contributed to the loss of millions of records. These breaches are dangerous to both citizens and cities, and resulting harms include identity theft and blackmail for citizens, and loss of public trust, legal liability, and the burden of remediation costs for cities[15].

As increasing numbers of cities adopt open data policies, city leaders are increasingly becoming aware that access to bulk information can produce its own privacy, security and liability concerns. Further, not all data needs to be protected in the same way. For example, data that a city has permission or authority to release publicly (such as a public phone directory for municipal employees) does not benefit from being anonymized or redacted. Alternatively, while releasing crime data may enable critical reporting about public safety issues, these data often include sensitive details that might infringe on the privacy or security of those impacted. Further, consider that data which might be too sensitive for release to the public online can often be used by academic or nonprofit researchers who have agreed to protect sensitive information and not release it, except in aggregate form or in other ways that limit the potential for harm[16]. These considerations illustrate the need to think through what should be released, to the extent permitted by law, and subject to privacy, confidentiality, security, or other restrictions and exemptions afforded under FOIA, or under federal-, state- and local laws[17].

In developing a data privacy policy, experts generally agree that law-based models are wholly inadequate, because the process for creating and amending laws necessarily lags behind technological advancement and innovation, and definitions of fundamental terms like *data* and *service* are constantly evolving; thus, under these frameworks, officials following the letter of the law open up potential privacy risks [18]. As an alternative, risk-mitigating *balance tests* provide city leaders with a standardized decision-making toolkit to codify and document the decision-making process behind whether data are made public, and what (if any) modifications or redactions must be made first[19]. While there is some subjectivity in weighing the public good versus the private right to privacy, language can be carefully crafted to weight specific elements, and to bring deliberate, documented rationale into the decision of whether to release, redact, or withhold civic data[20]. Such tests are currently used dozens of cities, both large and small. Balance testing rationales and methodologies employed in San Francisco[21] and Seattle[22] have won awards and praise from open data advocates and privacy champions alike and have been made publicly available for other cities to mimic[23].

Recommendations

To develop policies that balance data privacy with data openness, available literature[24,25] recommends the following guidelines:

- Catalogue all personally identifiable information residing in their environment, and minimize the use, collection, and retention of personally identifiable information to what is strictly necessary to accomplish their business purpose and mission.
- Consider developing processes to assess the release of sensitive or protected datasets that that balance the following factors:
    - the value of publishing the data,
    - an individual's expectation of privacy,

    - repercussions to an individual or the organization from re-identification
    - the likelihood of re-identification
- Create an incident response plan to handle data breaches, including coordination among their chief privacy officers, senior agency officials for privacy, chief information officers, chief information security officers, and legal counsel.
- Craft policies and procedures for identifying sensitive or protected data, performing risk assessments regarding identifiability, choosing and implementing privacy solutions (e.g. data de-identification), and performing risk assessments regarding the accessibility of deidentified data.
- Involve decision-makers throughout the "full life-cycle" of data – including collection, release, maintenance, and communication to the public.
- Ensure that citizens are informed and included in the process of data collection and privacy policies, which provides both understanding, comfort level and buy-in on the value of captured data to the city and their daily lives.

IoT and Smart Cities Infrastructure

For many years, the Internet of Things (IoT) has captured headlines by enabling "smart," sensor-enabled devices to communicate with each other, and with end users. IoT devices are increasingly being integrated into roads, public utilities, mass transit, hospitals and airports[26]. While in theory, IoT and connected civic infrastructure can allow city leaders to more efficiently utilize data to provide their constituents with an enhanced quality of life, including insights into infrastructure needing repair, allowing for predictive maintenance, or monitoring of water levels to alert and divert drivers in the case of flooding, there are two real-world challenges that often hamper these efforts: limited interoperability among devices from different vendors, and inadequate security in the face of increasingly sophisticated cyberattacks.

The concept of interoperability speaks to the ability of different devices from different (sometimes competing) vendors to communicate with one another. By 2020, approximately 24 billion IoT devices will be connected, and the key to harmonizing the interactions among these devices and encouraging interoperability is creating common standards outlining how devices, platforms, data formats, protocols, and applications will work together[27]. Generally speaking, however, these kinds of common standards are limited to vertical integration within devices produced by the same company, or devices produced for specific applications or industries[28].This lack of widely agreed-upon interoperability standards is a major gap in the IoT industry, and currently, city leaders who wish to manage the implementation of devices from multiple vendors often need to negotiate access individually and need to adapt to the platform-specific API and information models, and these efforts often outweigh the possible gains for application developers to adapt their applications to multiple platforms[29].

Of additional concern is that as IoT ecosystems grow in size and complexity, increased interconnectivity may expose vulnerabilities that criminals can exploit in order to cause damage to essential infrastructure, disrupt the flow of sensitive data, and steal personal- or sensitive information[30]. Consider the example of the 2016 *Mirai* cyberattack, in which criminals exploited a number of vulnerabilities in IoT devices, taking control of hundreds of thousands of them to unleash a cyberattack that disrupted the operations of several Internet providers, and caused well over $100 million in economic damages[31]. As increasing numbers of devices become connected to one another, IoT-based cyberattacks will only become more common, and it is estimated that by 2020, more than 25% of cyberattacks on enterprises will involve them[32]. Many IoT devices are insecure-by-design; for example, security keys may be permanently hard-coded into devices, and some transfer their data using unsecured, plain-text methods that can be easily discovered and stolen[33]. In addition, where security standards exist, they are often proprietary and incompatible with one another; and city departments with limited budgets are often challenged by the need to update security settings over multiple platforms, especially as embedded technologies become outdated[34].

In discussions surrounding IoT- and database security, there is tremendous buzz around the use of blockchain technology to make communication among devices safer and faster. Briefly, the blockchain is an alternative to using a central database; data held on a blockchain is shared among all devices that are connected to the network, and each device contains a transaction ledger for all of the changes made to any given file. This system is, by nature, more secure than a single database, because there is no "single target" for hackers. Although this model proffers great benefits for cities looking to implement security into their IoT strategies, it is also resource-intensive, because each transaction between devices is logged to a separate ledger kept by every device connected to the database. As more devices are

connected, each ledger can grow to hundreds of gigabytes *per device*, potentially resulting in large data storage needs and slower response times as devices and networks struggle to process the ever-growing files. In addition, a blockchain is only as good as its weakest links, and poor device security, especially on older hardware, creates significant vulnerabilities that can be exploited[35]. When considering the hundreds (or thousands) of sensors, computers, cameras, intelligent streetlights, and so forth that will be part of a city's IoT strategy, the limitations of storage space and network capacity make blockchains infeasible for citywide deployment[36].

Recommendations

In evaluating both interoperability and security among IoT devices, there is overwhelming agreement that city leaders should:

- Establish common guidelines, standards, and metrics for all vendors, including requirements for communication standards among devices (regardless of vendor), data types and storage methods, information sharing, data privacy, and security updates
- Require that IoT devices feature technologies like multimode radios, which allow devices to communicate using a variety of methods (e.g. cellular, WIFI, Bluetooth)
- Require vendors to guarantee software flexibility through networking protocols and APIs that can integrate with multiple services, and that can be updated to improve device capabilities and enhance security
- Promote public/private collaboration and information sharing IoT and smart infrastructure projects
- Implement clear, network-based, holistic risk management policies and procedures for all entry points into an IoT network, taking into account the specific needs of each point
- Incorporate cybersecurity considerations into existing procurement and maintenance policies and procedures.
- Establish cybersecurity crisis plans to ensure quick and practiced responses and processes to minimize impact.
- Perform regular risk assessments, penetration testing and auditing, and use the results, along with industry best practices, to inform changes to cybersecurity policies and procedures
- Provide adequate resources and financing for cybersecurity, while reframing cybersecurity as a benefit, rather than a cost

Procurement & RFPs

As city leaders continue to implement smart cities technologies, they increasingly find that traditional procurement processes face a number of challenges, including new technical features and infrastructure needs, complex ownership models, potential for new financial flows and revenue generation, and risks associated with the reliability, performance, and eventual obsolescence of ever-evolving technologies. Rising to the challenge, city leaders are finding innovative ways to procure public resources and engage with the vendors offering applicable technologies to urban systems, including public working groups, Requests for Information (RFIs), and the use of pilot programs and platform partnerships[37].

For their largest purchases, city leaders often issue an RFP to collect proposals from entities who might provide these goods or services. This has long happened behind closed doors, with confidentiality agreements shielding RFP responses from the public eye. To increase transparency, a growing number of cities are using smart city working groups and technical standards committees to map out smart city opportunities and engage citizens regarding what criteria should be included in an RFP. These groups and committees ensure public involvement in the RFP process, while allowing cities to require that proposals include proprietary information or solutions with the protection of non-disclosure agreements.

As an addition to the traditional RFP, more cities are now experimenting with using an RFI that precedes the RFP, and that functions as a kind of market analysis, allowing private-sector firms to respond with information relevant to the city's challenge or area of exploration. RFIs are especially prevalent in the smart cities space; because of the rapidly-changing nature of smart city technology, few in-depth market analyses exist, and those that do quickly become outdated. An RFI process allows a city to conduct its own analysis and engage in internal learning that informs the eventual call for proposals. While companies who respond to a city's RFI do not gain advantages in subsequent RFPs, they still often respond[38].

Finally, establishing pilot programs for new technologies offer city leaders the opportunity to familiarize themselves with different potential technology solutions, explore a given technology's value to city operations - including how well new technology can integrate and leverage existing technology and infrastructure investments - and gather input from the community prior to committing to a larger investment. Similarly, platform partnerships allow cities to test various vendors and tools on a temporary basis, without going through an official procurement process. By providing limited access to a technology package, private-sector vendors benefit by gaining an understanding of the true needs and challenges that a city faces, while city leaders and citizens benefit from having the opportunity to interact with- and offer feedback on the technology before it scales[39].

Recommendations

Available literature[40] recommends the following best practices for adapting municipal procurement processes to the rapidly-advancing world of Smart Cities technologies:

- Invest time in substantive pre-bid work, allowing vendors, citizens, and technical experts to help scope problems and solutions/approaches.
- Build technology upgrades and future risk mitigation into the RFP process; including planned obsolescence or required upgrades.
- Seek public-private partnerships to fund new initiatives, identifying mutual benefits including cost-saving potential.
- Be prepared for handling and vetting multiple sales pitches in response to RFIs.
- Test, iterate, and build trust; then scale.

Smart Cities and Legacy Zoning Codes

When done well, city codes make it easier for city leaders to implement their vision for smart, advanced infrastructure and real estate development; when they are out-of-date, they can hinder that vision. Municipal codes tend to lag behind technological development; and an unfortunate result is that code officers and courts generally have to use tools designed for earlier stages of development to deal with new challenges. Long-standing zoning regulations promoted disinvestment in the city center and made mixed-use projects difficult[41], but technological advances that now proffer to make cities *smart* also make it possible (arguably necessary) to reconsider legacy city codes[42], and to allow these technologies to solve the challenges that citizens face daily within the greater context of a city's overall development policies[43].

Across the country, city leaders are making changes to their zoning codes, in order to allow the built environment to catch up to the changing technological landscape, and to encourage adaptive reuse of existing space. In Detroit, for example, city leaders have proposed *pink zones*, or specific districts where some amount of bureaucratic red tape (e.g. parking minimums and certain environmental impact reports) is reduced or eliminated in favor of performance standards. This model benefits from the implementation of low-cost sensors to monitor noise levels, air quality, structural integrity, and crowd sizes, thus allowing city leaders to hold developers accountable by automatically triggering warnings or summon code compliance officers to their location to issue fines based on verified, recorded data[44].

An additional alternative to traditional zoning is the use of form-based zoning, which underscores the physical design of a place, rather than its use. Form-based zoning emphasizes the relationship between need and proximity, allows for smaller building footprints in already-developed districts, reduces parking requirements in favor of communal parking and pedestrian accessibility, minimizes setbacks, prohibits “blank wall” designs common to big-box retailers, and encourages narrow, walkable streets[45]. This model has been implemented in hundreds of cities across the United States, and can be implemented incrementally, allowing for citizen input in shaping the process. This is the approach taken in Cincinnati, where city leaders deployed form-based zoning first in pilot neighborhoods, before expanding outward on a community-by-community basis.

When zoning codes cannot be changed, or where the process may take years, another option is for city leaders to make it easier for developers to understand the options that they have available for development, especially the redevelopment of existing structures. Modern, online mapping software can be used to assist developers in identifying structures that may meet their needs, while also being aware of applicable city codes and zoning policies. For example, in Boston, city leaders implemented ZoningCheck, an online tool that allows business owners to quickly search zoning regulations based on the type of business they want to start or the area they want open in, creates interactive maps to help business owners narrow possible locations, provides links to commonly-required permits and applications, and gives contact information so that applicants can connect to the correct city employees if they have questions[46].

Certainly, sensors, online tools, and alternative zoning models are not necessarily meant to replace traditional zoning throughout a city; instead, the partnership between flexible zoning, traditional zoning, and technology can allow city leaders to focus on the truly vital regulations that protect the public, while revising or eliminating static policies that prevent cities from

evolving with changing times, citizen preferences, and technologies – policies that can ultimately harm the citizens they were designed to assist.

Recommendations

As city leaders think through how to balance the desire for innovative, adaptive uses of disinvested space with the public good that zoning codes help uphold, available literature[47] recommends the following guidelines:

- Ensure that new codes are enforceable, that they are easy to use and understand by non-experts, and that they will produce functional, vital change
- Streamline permitting and review processes to expedite appropriate development through integrated departmental software, single sign on portals and integrated data allowing the city to flag projects in the same geographic area to minimize neighborhood impact by multiple lane closures, trenching and other infrastructure disruptions
- Involve all relevant stakeholders, including developers, citizens, and business owners, in the code development process
- Avoid reinventing the wheel, by looking to peer cities with relevant knowledge for implementing the kinds of changes that city leaders want to see

[1] https://www.hpe.com/us/en/insights/articles/smart-cities-who-owns-the-data-1705.html
[2] https://efficientgov.com/blog/2016/06/22/copenhagen-data-marketplace/
[3] https://datasmart.ash.harvard.edu/news/article/how-cities-can-help-local-institutions-monetize-their-data-970
[4] https://datasmart.ash.harvard.edu/news/article/letter-open-data-community-one-year-later
[5] https://www.citylab.com/life/2017/04/maybe-government-data-shouldnt-always-be-free/523095/
[6] http://thegovlab.org/city-data-exchange-lessons-learned-from-a-publicprivate-data-collaboration/
[7] https://www.cigionline.org/articles/monetizing-smart-city-data
[8] https://labs.centerforgov.org/open-data/civic-data-standards/
[9] http://data.library.arizona.edu/sites/default/files/final-recommendations_0.pdf
[10] http://meetingoftheminds.org/standardized-indicators-for-informed-cities-6375
[11] https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/22563/Thomas2017.pdf?sequence=1
[12] https://datasmart.ash.harvard.edu/news/article/municipal-analytics-the-startup-way-873
[13] http://www.dcc.ac.uk/blog/10-recommendations-get-started-research-data-management
[14] https://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpg_2.jsp#dmp
[15] https://csrc.nist.gov/publications/detail/sp/800-122/final
[16] https://sunlightfoundation.com/policy/opendatafaq/
[17] https://www.opendatapolicies.org/guidelines/07-sensitive-information/
[18] https://datasmart.ash.harvard.edu/news/article/how-san-francisco-is-opening-more-data-with-a-premium-on-privacy-1135
[19] https://datasf.org/blog/4-steps-to-manage-privacy-and-de-identification-for-your-open-data-program/
[20] https://sunlightfoundation.com/opendataguidelines/
[21] https://datasf.org/resources/open-data-release-toolkit/
[22] https://fpf.org/wp-content/uploads/2018/01/FPF-Open-Data-Risk-Assessment-for-City-of-Seattle.pdf
[23] https://fpf.org/2018/01/25/examining-the-open-data-movement/
[24] https://sunlightfoundation.com/2014/03/25/safeguarding-sensitive-information-cant-be-done-without-a-balance-test/
[25] https://www.data.gov/sites/default/files/attachments/Privacy%20and%20Security%20Checklist.pdf
[26] https://www.enisa.europa.eu/topics/iot-and-smart-infrastructures?tab=publications
[27] https://www.networkworld.com/article/3205207/internet-of-things/iots-interoperability-challenge.html
[28] https://internet-of-things-innovation.com/insights/the-blog/iot-standards-interoperability/#.W1ihwNJKgkm
[29] https://www.einfochips.com/blog/role-of-iot-consortiums-and-standards-in-solving-interoperability-challenges-of-iot-ecosystems/#readmore
[30] https://securingsmartcities.org/wp-content/uploads/2017/09/SSC-SCCCM.pdf
[31] http://www.wired.co.uk/article/google-home-chromecast-location-security-data-privacy-leak
[32] https://www.techrepublic.com/article/why-blockchain-wont-transform-iot-security/
[33] https://www.mckinsey.com/industries/semiconductors/our-insights/security-in-the-internet-of-things
[34] https://iotsecurityfoundation.org/wp-content/uploads/2015/09/IoTSF-Establishing-Principles-for-IoT-Security-Download.pdf
[35] https://www.kaspersky.com/blog/bitcoin-blockchain-issues/18019/
[36] https://www.techrepublic.com/article/why-blockchain-wont-transform-iot-security/
[37] https://datasmart.ash.harvard.edu/news/article/smart-procurement-for-smart-cities-1192
[38] http://www.govtech.com/budget-finance/Treating-Smart-City-Procurements-Like-Open-Data.html
[39] https://www.usdn.org/uploads/cms/documents/2_2017_smartcities_vendor_draft4.pdf
[40] https://datasmart.ash.harvard.edu/news/article/smart-procurement-for-smart-cities-1192
[41] https://smartcitiescouncil.com/article/buffalo-links-smart-growth-place-based-city-planning
[42] https://www.forbes.com/sites/waynecrews/2018/01/11/who-will-own-the-infrastructure-in-the-smart-city/#58190e211ab4
[43] https://www.womblebonddickinson.com/uk/insights/articles-and-briefings/smart-cities-need-smart-laws
[44] https://www.sidewalklabs.com/blog/how-pink-zoning-can-jumpstart-urban-development/
[45] https://ieeexplore.ieee.org/abstract/document/7885770/
[46] https://www.linkedin.com/pulse/how-smart-cities-use-mobile-technology-more-business-friendly-bonner/
[47] https://www.epa.gov/smartgrowth/codes-support-smart-growth-development

Appendix F: Peer Cities

Chicago, IL: Array of Things and Lane of Things

Array of Things

First publicly announced in June of 2014, and launched in 2016, Chicago's Array of Things (AoT) is an urban sensing project composed of interactive, modular sensor nodes installed on streetlights throughout the city. This project is lauded as a leading example of collaboration via leadership from the City of Chicago, University of Chicago, Argonne Labs and Cisco. The project is led by Chicago's Department of Innovation and Technology, which manages the city's open data portal; the civic organization Smart Chicago Collaborative, a worldwide network of university-affiliated scientists; and private-sector partners such as Microsoft, Cisco, and Motorola[1].

Currently, just over 100 sensor nodes have been installed throughout Chicago, with plans to install 400 more. Each of sensor node collects real-time data on ambient lighting levels, temperature, vibration, carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, barometric pressure, sound intensity, and pedestrian and vehicle traffic. The data collected are increasingly available online, and provide valuable information for researchers, city leaders, and the general public[2]. For researchers, AoT data can drive innovative products and solutions to help make Chicago healthier and more livable, such as a mobile app that allows residents to track their exposure to certain air contaminants, or navigate the city while avoiding urban heat islands, poor air quality, or excessive congestion and noise. For city leaders, they help them make both short-term operations and long-term planning more efficient. For example, when city leaders are able to access hyper-local temperature data, they vastly improve their understanding of micro-level weather patterns and can better estimate where to apply salt before snow storms. For the general public, project leaders regularly hold meetings and workshops to build relationships with residents and identify community priorities using AoT data, such as monitoring traffic congestion around specific intersections to addressing air quality concerns at local parks and schoolyards.

Lane of Things

An outgrowth of the AoT project is the Lane of Things – a 2016 collaboration among education partners at Lane Tech College Prep High School, the Urban Center for Computation and Data, and the School of the Art Institute of Chicago. High School students built small, wooden boxes backed with sensors, a small computer, and a cellular modem, and over an eight-week period, the students used these sensors to execute their own experiments, measuring dust and methane produced by nearby construction, noise in the school's gyms, and hallway traffic patterns. Students also learned lessons about real-world data collection, as some of the sensors were vandalized, and sometimes data did not get recorded properly. After the eight-week project, students prepared research presentations for school officials, prompting these leaders to consider the use of technology to improve the school's overall environment.

Funding

The Array of Things has been supported by more than $1 million in internal research funding from Argonne, and a $3.1 million grant from the National Science Foundation.

Website (AoT): https://arrayofthings.github.io
Website (Lane of Things): https://tinyurl.com/y95c3bvc

Kansas City, MO: Open Data Dashboard, Public Data Policy, and Smart Cities Pilot & RFP

Online Open Data Dashboard (KCStat) and Public Data Policy

Kansas City's KCStat program began in 2011, as a data collection effort that focused on street maintenance, water line maintenance, water billing, customer service, code enforcement, and animal control[3]. Developed by government data company Socrata [the company that powers the Dallas Open Data platform], the dashboard is the city's way of offering residents more information about government performance through an easy-to-use interface and real-time dashboards that allow for drag-and-drop data comparisons. Visualizations include available parking, traffic flow, pedestrian hotspots and the location of streetcars. As the city's smart infrastructure expands, city officials plan to use big data to drive decisions that save money through more efficient repairs and maintenance of streets, water lines and other infrastructure projects[4].

While city leaders had long worked with data, and many of the KCStat strategic goals were tied to key metrics, department heads had not yet connected the work of frontline employees to City Council priorities. To address this, city leaders partnered with GovEx and the Sunlight Foundation to establish and convene an open data governance committee that brought together open data liaisons across multiple departments, as well as from the public, to conduct an inventory of City data and performance processes. This inventory allowed citizens and city staff to see what data the city collects, and then collaboratively set priorities around which data to review, clean, and publicly release. Open data is now the default practice across city departments, owing to a 2014 Council resolution directing city staff to make data open and available to the public whenever feasible, and with respect to confidentiality, intellectual property rights, the management of financial- and security risks, and the protection of privacy rights.

Smart Cities Pilot and RFP

In 2016, city leaders cut the ribbon on a smart city pilot program, built along a two-mile extension of Kansas City's streetcar network. Along the new line, intelligent streetlights react to lighting conditions and occupancy – they brighten and dim with the sun, and dim automatically if nobody is nearby[5]. Kiosks installed at several stops along the line allow riders to check arrival times and search for nearby attractions, dining, and retail. Blanketing the entire pilot area is a free, public WIFI network, which also aggregates data and helps city leaders determine where to expand network coverage, and even help determine where extensions to the streetcar line should go.

Building on the pilot project's early success, city leaders released an RFP, which aims to expand the project by several hundred additional blocks over the next several years, bringing connected technologies to solve for issues surrounding mobility, public safety, accessibility and improving quality of life. Example solutions include gunshot detection technologies, smart water-metering, and creating "geo-fencing" for public health alerts for asthma sufferers. The RFP calls for private-sector partners to design and build a fully-integrated suite of sensors, networks, and data analytics platforms, including approximately 800 Wi-Fi access points, approximately 300 traffic sensors, and approximately 30 digital information kiosks. This partner will work collaboratively with city staff on new projects, with an expected construction time of 30 months, divided into six-month sub-phases. Each sub-phase will expand the network by 18-25 blocks, according to the RFP, and the entire project will follow the extension of the city's streetcar line. Finally, the private-sector partner will be responsible for developing a long-term strategic plan, outlining the city's direction for the next 10 to 30 years, including priorities and a timeframe for specific initiatives. Additional RFP requirements

include the outline of a public-private partnership financial model that is anchored by private institutions financial commitment to leading financing efforts, minimizing upfront financial burden to the city's budget.

Funding

The pilot project is supported by private-sector partners like Cisco ($12 million over 10 years, plus a $3.7 million matching grant) and Sprint ($7 million for WIFI support), as well as operational- and energy savings from the lighting improvements (estimated at $4 million annually)[6].

Website (KCStat): https://data.kcmo.org
Website (Data Policy): https://tinyurl.com/yahb395s
Website (RFP): https://tinyurl.com/y72k5h8o

New York City, NY: NYCx and LinkNYC

NYCx

The Mayor's Office of the Chief Technology Officer (MOCTO) works with communities to identify urgent priorities and challenges the brightest minds in the world to address them using cutting-edge technologies through its NYCx program. Launched in October 2017, NYCx is a municipal program designed to convert urban spaces into hubs for tech collaboration, research, testing and development in real-world environments[7].

NYCx Co-Labs are designed to be hubs for experimentation and education located in high-need, high-opportunity neighborhoods, wherein local residents, city staff, and academic researchers can collaboratively identify- and test new solutions to neighborhood-specific concerns. In 2017, the first of these labs launched in the Brownsville community, in partnership with community organizations and City investment programs. The Co-Lab hosts public programs and workshops that allow New Yorkers to test and give feedback on technologies that aim to improve both quality of life and City services, as well as programs that highlight STEM careers and training programs through the city's Tech Talent Pipeline program[8]. It is also currently hosting a "Co-Lab Challenge" competition to enhance the community's nighttime activity and cultural programming in public spaces. Each challenge finalist will receive up to $20,000 for the necessary equipment to pilot their solutions at designated sites around the Brownsville neighborhood[9].

NYCx also hosts citywide "moonshot" challenges that are designed to encourage global entrepreneurs to partner with the City to propose transformative business models and solutions to large-scale problems like the digital divide and climate change. In early 2018, NYCx announced three finalists for its Connectivity Moonshot Challenge – Neutral Connect Networks LLC, Fiberless Networks, and Edge Fibernet – which will each receive $25,000 to test out their proposals for low-cost Wi-Fi and 5G cellular connectivity to Governors Island through 2025. Each of the finalists' proposals were required to service the needs of both today's visitors and the multi-use tenants of tomorrow, while withstanding risks associated with climate change. Once the overall winner has been determined, they will deploy their technology on Governors Island during the next public season[10].

LinkNYC

There are millions of people in New York City who don't have access to high-speed Internet. To solve this problem, city leaders entered into a multi-year contract with CityBridge, a private-sector telecommunications consortium, New York City will replace payphone stands with digital kiosks produced by CIVIQ Smartscapes. This program, called LinkNYC, will install 7,500 kiosks across the city, and each kiosk will provide free Wi-Fi access, nationwide phone calls, access to 911 and 311, interactive wayfinding and transit updates, and the ability for users to anonymously search for nonprofit- and social services[11]. Since the 2016 rollout, over 3 million people have signed up for Wi-Fi access, but the system has not been without flaws. Notably, shortly after the first kiosks were installed, complaints arose regarding misuse of these terminals, particularly about people overusing the kiosks and watching inappropriate content; in response, open Internet access was disabled across the network[12]. Further, over the first two years of the program, revenues have been lower than expected; details and results of this development are discussed below[13].

Funding

Support for the Brownsville Co-Lab is provided by MOCTO, in partnership with the Brownsville Community Justice Center, in partnership with the Center for Urban Science & Progress (CUSP) and the NYC Economic Development Corporation (EDC)[14]. Moonshot- and Co-Lab Challenges are supported by CUSP, EDC, the Mayor's Office of Criminal Justice, and the NYC Department of Transportation.

Initial funding for LinkNYC came from members of the CityBridge consortium, including approximately $25 million each from Qualcomm and JMC, and an additional $50 million from advertising companies and software firms that have been merged under the name Intersection, with Sidewalk Labs being the lead investor[15]. The New York City Regional Center has also provided over $150 million in loans to the consortium. Over the length of the original contract, New York City is scheduled to receive a minimum annual payment of $42.5 million, plus half of the advertising and partnership revenues. However, the program has struggled to generate more than this minimum payment, and the original agreement has since been modified to allow CityBridge to delay paying the city its share of the revenues above the annual minimum payments until the last three years of the contract, when those profits will be due with 10% interest[16].

Website (NYCx): https://tech.cityofnewyork.us/teams/nycx/
Website (LinkNYC): https://www.link.nyc

Pittsburgh, PA: University Partnerships

University Partnerships

For over a decade, the City of Pittsburgh has engaged with the higher education community, including Carnegie Mellon University (CMU), the Community College of Allegheny County, the University of Pennsylvania, and The Ohio State University to explore application of smart city transportation initiatives, including connected and autonomous vehicles; improved transportation access to disadvantaged neighborhoods; multi-modal traveling; assistive technologies for people with disabilities; data modeling for monitoring traffic control systems; and regional planning to establish priorities and aid transportation deployment[17]. Aside from improving lives for the citizens of Pittsburgh and the surrounding area, this collaboration has resulted in national recognition, including the city's selection as a finalist for the Department of Transportation's Smart City Challenge[18], and the city's 2018 inclusion in Transportation for America's Smart Cities Collaborative[19].

Pittsburgh's university partnerships first developed the Traffic21 program in 2009, with a goal of identifying and implementing technological advancements within Pittsburgh region's transportation system. That initial funding has spurred additional investment in transportation technologies and innovation in the region; for example, Surtrac (a private-sector firm spun off from Traffic21) developed an AI-enabled traffic system that allows the city's streetlights to communicate with one another in real-time. On thoroughfares where the lights have been installed, commute times have been reduced by roughly 25%, braking has been reduced by 30%, and idling has been reduced by over 40%[20].

A spinoff of Traffic21, Metro21 is an initiative that aims to combine technology and policy to allow city leaders to take the pulse of infrastructure, services and civic engagement throughout Pittsburgh[21]. The initiative takes existing systems (e.g. roads, buses, sidewalks) and improves them through integration of technology. For example, smartphones mounted on the dashboards of garbage trucks film road conditions; this video is fed to computer algorithms that make real-time recommendations to city leaders for new traffic signal timing, street repair needs, snow plow routing, and long-range transit planning[22].

These successes led to the 2017 creation of Mobility21, a federally-funded transportation research center dedicated to multimodal transportation research, deployment and technology transfer, education and workforce development, and diversity initiatives. With over two dozen active research projects and pilot programs, the center is well-positioned to transform mobility solutions throughout the region, with each project focused on creating a deliverable solution to real-world mobility concerns[23].

Funding

This collaboration was initially funded by businessman, civic leader and philanthropist Henry Hillman through the Hillman Foundation, and since then, aggressive pursuit of research grants has attracted over $14 million in funds from the Department of Transportation, with additional funding available under the Fixing America's Surface Transportation (FAST) Act[24].

Website (Traffic21): https://traffic21.heinz.cmu.edu
Website (Metro21): https://www.cmu.edu/metro21/
Website (Mobility21): http://mobility21.cmu.edu

San Diego, CA: IoT Platform

IoT Platform

Across San Diego, thousands of streetlights throughout the city are being upgraded, making the city one of the largest city-based IoT platforms in the world. Within San Diego's urban core, 3,200 luminaires are being replaced with models that also contain connected sensor arrays[25]. These intelligent nodes will combine technologies from AT&T (data & connectivity) Current (sensor arrays), ShotSpotter (gunshot detection), Intel (local data processing), and Proximitry (application management), and will provide city leaders with real-time sensor data that can be used to develop applications that will benefit citizens, including the ability to direct drivers to open parking spaces, assist first responders with locating emergency scenes, increasing public safety, optimizing municipal systems, and allowing real-time environmental monitoring[26].

In addition to the upgrades within the city center, 14,000 luminaires citywide are being refitted to house connected, fully adjustable LEDs. Each fixture comes equipped with an advanced control system, developed by Current, that allows city managers to dim, brighten and check for outages and maintenance issues remotely, using a single dashboard. By reducing power consumption through the increased efficiency of LEDs versus metal halide bulbs, as well as allowing the lights to adjust based on need, energy costs will be reduced by an estimated $2.4 million annually.

Funding

Initial implementation of this $30 million project is funded by private sector partners, through Cleantech San Diego – a nonprofit, membership-based association, dedicated to encouraging collaborations across the public-private-academic sectors and leading advocacy efforts around cleantech priorities and San Diego-area investment[27]. In addition, Community Development Block Grant (CDBG) funds are being used to ensure that lighting improvements can be made in even the most underserved communities[28]. The project's second phase aims to expand the number of intelligent sensor nodes by 3,000, while also leveraging state grants to invest in upgrading the infrastructure of municipal buildings, with the goal of reducing municipal building energy consumption by 15% by 2020 and by an additional 25% by 2035[29].

Website (City of San Diego): https://www.sandiego.gov/sustainability/smart-city
Website (Cleantech San Diego): http://cleantechsandiego.org/smart-city-san-diego/

San Jose, CA: Smart Cities RFP and Public-Private Partnership (P3) Model

Smart Cities RFP & P3

In 2017, approximately 100,000 residents in the San Jose were not connected to the internet at home. To solve this problem, city leaders issued a request for proposal (RFP) to help develop and implement a citywide strategy around improving digital inclusion, based on three goals. First, city leaders wanted to improve residential and business broadband internet choices, including both quality and pricing; second, city leaders wanted to promote availability of gigabit level broadband internet to support economic development; and third, city leaders wanted to improve access to social services and educational outcomes, especially among low-income and vulnerable populations (e.g. people with disabilities, elderly individuals, immigrants, people with poor credit or who are unbanked)[30].

The result of this RFP is a public-private partnership (P3) between the City of San Jose and three existing telecommunications companies: AT&T, Verizon, and Mobilite. This partnership represents one of the largest small cell deployments in the United States, with approximately 5,000 small cell sites for the three companies combined, subject to final negotiation, as well as approximately 800 miles of new fiber outlay to support the network and expand Internet access throughout the city, while also bolstering the capacity and resiliency of the FirstNet emergency responder communications network. The small cell network will also serve as the foundation for 5G service in 2019, and will facilitate a number of pilot programs, including intelligent LED lighting grids, public Wi-Fi access, and digital monitoring of civic infrastructure and buildings[31].

The small cell network and improved digital infrastructure also serve to support San Jose's Digital Inclusion Plan, which recognizes that low-income and vulnerable populations (often lack broadband access, and that the primary barrier is cost of devices and service, with additional barriers found in privacy concerns and lack of digital literacy. Although the plan's implementation is still in formative stages, it calls for the City to act as the backbone of a collective impact organization, charged with coordinating and amplifying the wide variety of existing programs throughout the city, including programs like coding camps, device and connectivity providers in low-income communities, and ad-hoc programming provided by community organizations and libraries – in effect, the City will act largely as a capacity builder, rather than as a direct service provider[32].

Funding

San Jose's small cell network is funded by a private-sector investment of more than $500 million in San Jose's broadband infrastructure, an additional $4 million in in-kind investment by the partnership members, and $1 million in grants from partnership members to accelerate deployment[33]. The city's Digital Inclusion Plan is being funded by the public-private partnership as well, with $24 million in initial investments, and annual leasing revenues of $1,500 per small cell site over the next 15 years. In addition, the Knight Foundation has awarded San Jose with a $500,000 grant to support digital inclusion[34].

Website (P3): http://www.sanjoseca.gov/DocumentCenter/View/78342
Website (Digital Inclusion Plan): https://tinyurl.com/ydb767sb

[1] https://datasmart.ash.harvard.edu/news/article/a-guide-to-chicagos-array-of-things-initiative-1190
[2] https://arrayofthings.github.io
[3] http://www.govtech.com/data/Kansas-City-Measures-Performance-through-Online-Dashboard.html
[4] https://gcn.com/articles/2017/02/10/kansas-city-nist-smart-city.aspx
[5] https://www.huffingtonpost.com/entry/kansas-city-smart-technology_us_572cf566e4b016f37895d160
[6] https://www.computerworld.com/article/2984802/internet-of-things/kansas-city-presses-on-with-emerging-smart-city-corridor-with-video.html
[7] https://tech.cityofnewyork.us/teams/nycx/
[8] https://tech.cityofnewyork.us/projects/nycx-co-labs/
[9] http://www.nyc.gov/html/nycx/nighttime/nighttimefaq.html
[10] https://www.techrepublic.com/article/nyc-uses-moonshot-challenge-to-accelerate-5g-wireless-in-the-city/
[11] https://www.nytimes.com/2018/01/11/nyregion/what-are-those-tall-kiosks-that-have-replaced-pay-phones-in-new-york.html
[12] https://www.forbes.com/sites/janetwburns/2016/09/16/linknyc-drops-web-browsing-from-its-kiosks-after-people-unsurprisingly-watch-porn/#a8fc96c14718
[13] https://nypost.com/2018/05/01/nycs-free-public-wi-fi-kiosks-arent-making-enough-money/
[14] https://tech.cityofnewyork.us/projects/nycx-co-labs/
[15] https://www.reuters.com/article/us-qualcomm-jmc-new-york/qualcomm-jmc-seek-to-exit-alphabet-backed-new-york-wifi-project-sources-idUSKBN1D166C
[16] https://nypost.com/2018/05/01/nycs-free-public-wi-fi-kiosks-arent-making-enough-money/
[17] https://www.cmu.edu/engage/about-us/news/partner/mobility21.html
[18] https://www.transportation.gov/smartcity/7-finalists-cities
[19] http://wesa.fm/post/pittsburgh-selected-nerd-out-transportation-22-other-smart-cities#stream/0
[20] https://www.smartcitiesdive.com/news/this-ai-traffic-system-in-pittsburgh-has-reduced-travel-time-by-25/447494/
[21] https://www.cmu.edu/work-that-matters/smart-cities/
[22] https://www.cmu.edu/metro21/projects/transportation/index.html
[23] http://mobility21.cmu.edu
[24] https://www.cmu.edu/engage/about-us/news/partner/mobility21.html
[25] http://cleantechsandiego.org/san-diego-deploy-worlds-largest-city-based-internet-things-platform-using-smart-streetlights/
[26] http://www.shotspotter.com/press-releases/article/partner-press-release-san-diego-to-deploy-worlds-largest-smart-city-iot-pla
[27] http://cleantechsandiego.org/about/
[28] https://www.sandiego.gov/sustainability/smart-city
[29] http://cleantechsandiego.org/city-san-diego-smart-city-project-awarded-funding/
[30] http://www.sanjoseca.gov/index.aspx?NID=5557
[31] http://about.att.com/story/san_jose_public_private_partnership.html
[32] https://ww2.kqed.org/news/wp-content/uploads/sites/10/2018/01/Digital20Inclusion20Report.pdf
[33] https://www.techwire.net/news/att-san-jose-aim-to-expand-small-cell-network.html
[34] https://www.knightfoundation.org/press/releases/six-silicon-valley-community-2013

Appendix G: Use Cases & KPIs

Living Lab Use Cases
Focus areas: citizen engagement, public safety, resource efficiency, resiliency, public health, mobility, neighborhood revitalization

Connectivity
Deliver ubiquitous connectivity for citizens and power the West End Living Lab

- Power all West End living lab use cases
- Seamless network infrastructure to support citizen engagement
- Connectivity via combination of fiber, Wi-Fi and cellular
- City own and implement public Wi-Fi network in the Living Lab

Digital Kiosks
Engage and protect citizens with relevant, timely and helpful information

- Interactive screen for Wayfinding & Transit services
- Display public education content around city events, DART, voter registration, etc.
- Display content about smart city performance/savings
- Customizable and remotely managed content
- USB charging
- Emergency alerts integrated into display
- Advertising revenue modeling

Narrative: Neighborhood Revitalization
Demonstrate Living Lab's contribution to increased investment and livability in the West End

- Real estate investment and interest
- Makeup of companies, residents, and visitors in the West End
- Involvement of businesses, property owners, startups, and citizens in the Living Lab

Public Safety
Improve both the perception and reality of safety in Downtown Dallas generally, and the West End specifically

- Expanded/improved street lighting
- Emergency services integration with kiosks
- Emergency alert system via kiosks and related citizen app
- Measurement of foot traffic to inform pedestrian patterns and spikes in activity

Smart Lighting
Citizens feel safe, and can easily walk and park in the West End. Energy usage and cost savings.

- Intelligent automated LED lights for energy efficiency
- Environmental sensors for air quality; crowd, and noise sensors for citizen safety
- Parking optimization with video cameras

Smart Transit and Parking
Provide citizens with real time transportation data

- Parking utilization rates and revenue increases
- Consumer sentiment regarding Downtown parking (citizen survey)
- Consumer sentiment regarding mass transit (citizen survey)
- Bike share / ride share utilization (pending)

Smart Waste Management (For Future Consideration)
Create a cleaner environment for citizens, reduce CO2 emissions, and increase recycling

- Automated data allows trash to be picked up when full
- Solar-powered system increases capacity and eliminates overflows at collection points
- Enclosed design prevents pilfering, pests access, and windblown litter

Smart Water Management: Automated Metering Infrastructure (AMI)
Implementation of AMI system

- Optimized & efficient meter reading
- Remote service discount and move-in/move-out reading
- Tamper & meter alerts - deters water theft
- Customer leak alerts – reduces water loss
- Enhanced acoustic distribution leak detection
- More granular usage data for increased consumer awareness and proactive conservation

Smart Water Management: Irrigation
Increase greenspace enjoyment for citizens; decrease water costs for the City

- Smart meters eliminate overwatering of parks
- Water at most efficient time of day reduces water waste
- Track and manage watering activity remotely
- Remotely reports outages and breakage of irrigation systems to expedite repairs
- Maximize citizen enjoyment of public greenspaces

Living Lab KPIs

Citizen Engagement

- Measurements related to kiosk usage
    - Overall interactions, specific functions utilized, impressions
- WIFI usage of City public-WIFI network
- Interaction with walking tour and other immersive programming surrounding the Living Lab
- Activity and utilization of Open Data Platform/API (release pending)
- Hackathon attendance and outcomes

Connectivity

- Performance
- Stability
- Speed
- WIFI adoption rate (e.g. individuals, duration, usage)

Digital Kiosks

- User counts & interactions
- Average length of use
- Utilization rates per feature/function
- Advertising revenue potential
- Performance of system and connectivity

Economic Development

- Local business revenues and customer count
- Foot traffic, bike traffic, & automobile traffic
- Employees / workforce growth
- New businesses created or relocating into the area
- Tourism / spending increase

Environment

- Testing of new technology alongside City of Dallas Office of Environmental Quality
- Measurement of Temperature, Humidity, CO2, NO2, Ozone and three kinds of particulate matter.
    - Identification of events of decreasing air quality.
- In Development: correlation between vehicle traffic, special events and other factors in air quality measurements.

Public Safety

- Decreased crime rates
- Improvement in case resolution rate
- Increased citizen crime reporting
- Increased pedestrian presence and foot traffic
- Perception survey

Smart Lighting

- Energy use reduction (lighting usage)
- Energy cost reduction to City
- Operational efficiencies
- Correlation with public safety data
- Public perception: quality of illumination, sense of well-being, feelings of safety, etc.
- Correlation with pedestrian traffic and business revenue

Smart Parking

- Parking utilization rates & revenue increases
- Consumer sentiment regarding Downtown / West End parking
- Increased DART ridership
- Increased bikeshare usage & revenues
- Consumer sentiment regarding mass transit
- Increased rideshare usage
- App utilization

Smart Water Management: Automated Metering Infrastructure (AMI)

- Optimized & efficient meter reading; reduced reading expense
- Remote service discount and move-in/move-out reading; eliminates truck rolls
- Tamper & meter alerts to detect water theft and reduce non-revenue water
- Customer leak alerts to reduce water loss
- Enhanced Acoustic Distribution Leak Detection reduces water loss by tracking unaccounted-for water (which can be as high as 30%)
- More granular usage data and robust analytics for increased consumer awareness and proactive conservation

Smart Water Management: Irrigation

- Water use reduction
- Soft benefits – plant health, public perception (i.e. not seeing wasted water on street/sidewalk)
- Staff time reallocation (i.e. less on regular controls, maintenance, repairs; more able to work on other projects)
- Decreased time from when problems occur to remediation / Service Request fulfillment (via automated sensor alerts)
- Maintenance cost degreases (irrigation and DWU)

Appendix H: Overarching Data from the Living Lab

	Resource Efficiency: Intelligent LED Streetlights				Citizen Engagement: Interactive Digital Kiosk				
	Total Energy Used (kWh)	Total Energy Costs ($)	Total Energy Saved* (kWh)	Total Energy Costs Saved* ($)	Unique User Sessions	Points of Interest Located	Souvenir Photos Taken	Souvenir Photos Shared	Users Interacting with Multiple Features (%)
Apr. 2017	695.38	$15.99	132.62	$3.05	**Kiosk Activated Aug. 2017**				
May 2017	600.42	$13.81	255.18	$5.87					
Jun. 2017	525.64	$12.09	302.36	$6.95					
Jul. 2017	533.25	$12.26	322.35	$7.42					
Aug. 2017	572.90	$13.19	282.70	$6.49	316	156	349	141	70%
Sep. 2017	537.03	$12.42	290.97	$6.62	256	123	108	61	46%
Oct. 2017	632.64	$12.76	222.96	$6.92	207	506	251	146	46%
Nov. 2017	577.05	$13.25	250.95	$5.80	462	628	358	208	46%
Dec. 2017	574.18	$13.19	281.42	$6.49	672	439	873	446	55%
Jan. 2018	540.67	$12.41	314.93	$7.27	680	466	1147	305	55%
Feb. 2018	584.17	$13.46	188.63	$4.31	145	64	323	194	55%
Mar. 2018	608.90	$13.97	246.70	$5.70	535	300	822	475	49%
Apr. 2018	409.28	$9.41	418.72	$9.63	541	272	1050	593	53%
Cumulative	**7391.51**	**$168.21**	**3510.49**	**$82.52**	**3814**	**2954**	**5281**	**2659**	**N/A**
Monthly Avg.	**568.58**	**$12.94**	**270.04**	**$6.35**	**328**	**328**	**587**	**285**	**53%**

* estimated based on industry standards for metal halide luminaires

	Neighborhood Revitalization:							
	Pedestrian Traffic Counts & Monthly Trends				Local Business Revenue & Customer Count		Public Safety	
	Pedestrian Count (Market @ Ross)	**Monthly Change (Market @ Ross) (%)**	**Pedestrian Count (Market @ Elm)**	**Monthly Change (Market @ Elm) (%)**	**Monthly Revenue Change (%)**	**Monthly Customer Count Change (%)**	**Year over Year Crime Rate (%)**	**Crime Rate vs. Prev. Month (%)**
Apr. 2017	89,653	-	40,872	-	↑ 0.4%	↓6.3%	↑ 78%	↓ 11%
May 2017	64,825	↓ 28%	44,671	↑ 9%	↓ 7.0%	↓7.5%	↓ 42%	↓ 45%
Jun. 2017	89,257	↑ 38%	38,287	↓ 14%	↑ 5.3%	↑ 7.1%	↓ 5%	↑ 33%
Jul. 2017	44,134	↓ 51%	30,751	↓ 20%	↑ 2.9%	↑ 2.3%	↓ 35%	↓ 54%
Aug. 2017	69,506	↑ 57%	56,007	↑ 82%	↓ 4.7%	↓4.6%	↑ 67%	↑ 25%
Sep. 2017	117,944	↑ 70%	63,482	↑ 13%	↑ 4.0%	↓7.7%	↓ 33%	↓ 63%
Oct. 2017	52,477	↓ 56%	67,187	↑ 6%	↑ 1.5%	↑ 10.6%	↓ 17%	↑ 150%†††
Nov. 2017	96,801	↑ 84%	71,628	↑ 7%	↑ 35.0%	↑ 24.0%	↑ 13%	↓ 50%
Dec. 2017	143,969	↑ 49%	68,330	↓ 5%	↑ 32.0%	↑ 17.0%	↓ 27%	↑ 22%
Jan. 2018	160,030	↑ 11%	68,464	↑0.2%	↓ 46.9%	↓42.0%	-	-
Feb. 2018	-	-	-	-	↓4.9%	↑ 0.9%	-	-
Mar. 2018	102,523	-	63,389	-	↑ 27.9%	↑ 22.1%	↓ 37%	*no change*
Apr. 2018	-	-	58,320	↓ 8%	↓ 16.0%	↓11.4%	↓ 60%	↓ 33%
Cumulative†	**-**	**-**	**-**	**-**	**↑ 45.5%**	**↑ 15.9%**	**-**	**-**
Monthly Avg.††	**93,738**	**↑ 19%**	**55,733**	**↑ 7%**	**↑ 3.8%**	**↑ 1.3%**	**↓3%**	**↓2%**

† cumulative values not given where data are not contiguous
†† averages calculated using only months where data are reported
††† no recorded increase in violent crime

	Public Health: Environmental Data								
	Temperature (°F)			Humidity (%)			Barometric Pressure (Pa)		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Apr. 2017	71	41	96	63%	25%	100%	996.3	703.0	1009.0
May 2017	77	52	98	58%	22%	98%	995.8	987.6	1004.7
Jun. 2017	83	65	108	66%	27%	100%	995.0	986.2	1006.0
Jul. 2017	88	69	108	61%	28%	100%	998.5	987.8	1003.9
Aug. 2017	75	73	93	55%	42%	99%	992.1	985.7	997.8
Sep. 2017	82	65	102	58%	17%	100%	997.5	990.2	1006.1
Oct. 2017	71	36	99	52%	16%	100%	1000.7	985.8	1012.9
Nov. 2017	63	39	96	66%	21%	100%	1001.4	988.3	1012.5
Dec. 2017	49	26	83	66%	13%	100%	1005.4	991.5	1018.9
Jan. 2018	48	17	76	55%	19%	100%	1008.0	988.5	1027.8
Feb. 2018	49	27	78	79%	23%	100%	1003.4	989.2	1017.5
Mar. 2018	65	41	92	58%	14%	100%	1000.1	985.3	1012.4
Apr. 2018	74	36	105	63%	19%	100%	998.0	981.2	1011.9
Yearly Avg.	**68**	**45**	**95**	**62%**	**22%**	**100%**	**998.0**	**992.0**	**1005.0**

	Public Health: Air Quality & Pollutants																	
	Carbon Monoxide (CO) (ppm)			Nitrogen Dioxide (NO_2) (ppb)			Sulfur Dioxide (SO_2) (ppb)			PM1 ($\mu g/m^3$)			PM2.5 ($\mu g/m^3$)			PM10 ($\mu g/m^3$)		
	Avg.	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**	**Avg.**	**Min.**	**Max.**
Apr. 2017	1.2	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	72.4	5.9	0.0	96.2	10.9	0.0	259.0
May 2017	0.9	0.3	2.6	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.2	16.6	5.6	0.3	58.1	8.6	0.3	70.7
Jun. 2017	0.4	0.0	3.0	0.1	0.0	1.0	0.0	0.0	2.5	3.7	0.3	16.0	5.1	0.4	47.6	6.2	0.4	90.2
Jul. 2017	0.4	0.0	14.1	0.1	0.0	0.8	0.0	0.0	2.3	4.0	0.1	16.0	5.5	0.1	35.5	6.8	0.1	67.0
Aug. 2017	0.8	0.0	18.9	4.7	0.0	1,563.0	1.1	0.0	4,107.0	0.9	0.1	15.3	1.4	0.1	58.9	1.4	0.1	59.1
Sep. 2017	0.5	0.0	15.2	61.3	0.0	955.0	2.5	0.0	4,077.0	4.6	0.2	15.9	5.7	0.2	61.7	6.7	0.2	61.9
Oct. 2017	0.6	0.0	2.8	40.0	0.0	789.0	0.0	0.1	196.0	2.6	0.1	16.0	3.6	0.1	68.1	5.2	0.1	76.1
Nov. 2017	0.7	0.0	2.9	14.6	0.0	1,915.0	0.7	0.0	1,819.0	4.6	0.1	16.0	9.0	0.2	87.9	10.5	0.2	96.5
Dec. 2017	0.8	0.0	2.8	1.5	0.2	3.8	0.2	0.0	546.0	3.8	0.1	16.0	9.3	0.1	100.0	8.8	0.1	95.7
Jan. 2018	9.1	0.5	35.4	0.1	0.0	473.3	0.1	0.0	289.4	2.7	0.1	16.0	5.2	0.1	85.6	6.9	0.1	99.4
Feb. 2018	8.3	1.8	34.6	0.1	0.0	232.4	-	-	-	5.1	0.1	16.0	12.8	0.1	99.8	14.3	0.1	99.9
Mar. 2018	7.3	0.0	28.2	0.1	0.0	375.1	-	-	-	3.9	6.1	8.2	0.1	0.1	0.1	16.0	92.2	99.4
Apr. 2018	0.6	0.0	2.4	37.9	0.0	274.5	-	-	-	3.3	0.1	16.0	4.8	0.1	89.2	6.6	0.1	92.4
Yearly Avg.*	**2.4**	**0.7**	**12.8**	**14.6**	**0.0**	**598.5**	**0.6**	**0.0**	**1,379.9**	**3.6**	**0.6**	**19.7**	**5.7**	**0.2**	**68.4**	**8.4**	**7.2**	**97.5**

* averages calculated using only months where data are reported

Appendix I: Map of the Smart Cities Living Lab