Tulsa's Smart City Transportation Initiative

U.S. Department of Transportation
Beyond Traffic: The Smart City Challenge

U.S. Congressional District OK-01

Tulsa, Oklahoma

Submitted by:

CITY OF
Tulsa
A New Kind of *Energy*.

Executive summary: Creating a Vibrant City by Leveraging Technology

Tulsa and the surrounding region has been on a consistent growth path with nearly 1 million people and a diversified industry and economy. With increased freight and personal travel the City faces traffic and transportation issues. In light of this, the City of Tulsa aims to become an innovation model for how a growing economy uses data to effectively manage, grow and sustain a high-performance transportation system that is inclusive of all users. High traffic volumes, a vision to realize zero-fatalities by 2045, and a transforming public transportation system designed to attract choice riders combined with concentration of traffic along certain arterial corridors affords the unique opportunity for the City of Tulsa to transform and address the challenges of the future.

The City of Tulsa proposes to use a comprehensive, yet focused approach that brings together multi-disciplinary partners to **improve safety and traffic flow, integrate systems, and establish responsive transportation based on user-driven need**. This effort will employ a strategy that relies on citizen engagement, data-driven decision making and governance. For the City of Tulsa to realize its vision, it will need to establish an inclusive and holistic information strategy along with optimizing the transportation infrastructure already in place. This would allow the city to capture, analyze and use data generated from many sources, including sensors and transit users, and then share the data across all other platforms such as smartphones, mobile apps and social media, and across organizations, such as government agencies, private companies and nonprofits.

The Smart Cities Challenge grant will help with an organized approach to the current and future transportation issues. Researchers at the University of Oklahoma and the University of Tulsa, combined with the supercomputer housed at Tulsa's City Hall, will develop a data exchange platform to manage information flow among subsystems. This will enable the resolution of transportation issues in a timely manner.

The following specific ideas will be explored as a part of the Smart Cities Challenge:

- Improve **operational efficiency** and maximize the current transportation infrastructure, the City of Tulsa Traffic Engineering Division will improve the overall traffic experience by extending the scope of data used to analyze traffic patterns, leveraging real-time data, applying adaptive analysis.
- Create a **seamless traffic and transit user interface** to provide a comprehensive tools to public to make travel decisions.
- **Improve cooperation** among governmental agencies and citizens. With help from the MPO, the region will establish a communication and engagement strategy based on shared data, analysis and reporting.

I. A Vision for a Midwestern Smart City

Opportunities

Since the oil industry crash of the 1980s, the City of Tulsa has moved to diversify its economy to include not only fossil fuels, but also telecommunications, aerospace, and health care. Industry has built extensive fiber optic connectivity along most of its expressway corridors and old pipeline rights-of-way that linked many other hubs across the nation. Steady growth in population and employment provides Tulsa an opportunity to transform into a next generation city. Elected officials, residents, philanthropists and business leaders are determined to making Tulsa a city for young professionals, engaging older residents with services, and improve the quality of life for all.

What would Tulsa look like in 2045?... and beyond; the answer may depend on the rate of change that is seen over the past 30 years. As an auto-centric American city, the City of Tulsa expanded with growth in auto-ownership, increase in automobile traffic, suburbanization, increased trip lengths, more traffic incidents, and increased vehicle miles traveled. While there have been some modest improvements to emissions and air quality, these are all common characteristics of a mid-size North American city.

The transformation of city economy and the growth in diversity of people and industry coupled with new technologies has challenged the direction for City's growth over the recent years. This challenge has been embraced by one of the nation's largest young professional organization, the chamber of commerce and city leaders to adapt concepts related to increasing densities, zoning overhauls, and adapting the latest technologies to transform into a smarter city.

The most immediate beneficial effect of such a change a reduction in crashes. **Improving safety** has become the first priority for all transportation leaders. Technology enabling all travelers to pursue their work and life in safest circumstance possible will be the centerpiece of Tulsa's surface transportation in 2045 and beyond.

Technological improvements over the past decade now make peoples' travel, work, home environments to combine and achieve **greater productivity** with flexibility that was not known during the 80s and 90s. Twenty-four hour connectivity to the workplace is mode possible while not losing family connections.

Challenges

We aren't there yet, but city leaders envision a parent not worrying about a **child crossing the street** - because a crash avoidance system on the car combined with safe crossing zones, where the technology will prevent the crash, is in every school zone throughout the city.

A **grandmother in her 80s** driving to her favorite cafe in winter need not worry about an icy sidewalk or the parking spot not available for her car that is able to self-park, and

perhaps self-drive, given the GPS coordinates of the parking spot. Her family will be able to check on her well-being as she parks.

Gridlock at a busy interchange will alert travelers about the clearance time or travel time through that interchange so a car's GPS can suggest another route to destination. Google Voice will alert the traveler in advance anticipating congestion based on previous years data for the same time and date, based on history.

These are not hypothetical stories. They are stories of Tulsans. In 2013, a child and her mother tried to cross a street on South Peoria in Tulsa and both were hit by a car because there was not adequate lighting or a marked crosswalk. A grandmother in her 80s was leaving to go to her car from a cafe and was also hit and killed by a car. The status of gridlock on the major interchange in Tulsa at the BA Expressway and US-169 is always an unknown to motorists leaving downtown, leaving motorists without good decision-making ability on alternate routes.

This particular highway interchange improvement is expected to cost $160 million in 2015. Cost of lives taken by car crashes in other two scenarios exceeds $5 million. There were over 40 traffic fatalities in the past one year alone. The Tulsa averages 45 fatalities per year on city streets. There were 681 fatal crashes in Tulsa over the past fifteen years. NHTSA estimates the cost of a fatality at nearly $1.4 million. At price, about **$1 billion is lost to fatalities alone in Tulsa within the past 15 years**. It is a cost that can never be recouped. In the next 30 years, beyond 2045, that cost, even if it stays at the same price in 2015 dollars will be close to $2 billion.

The nexus represented by safety concerns, recurring congestion, and traffic operational challenges lead to poor air quality, degraded climate, and deprives all residents the opportunity to live in a smart city. **This grant will help to bridge the gap between the opportunities and challenges presented.**

II. Tulsa's Approach

The Smart City challenge grant will address the following for the City of Tulsa.

1) Growing demand for widening streets that could be better managed with **adaptive traffic signal systems.**

2) Eliminating alternative mode crashes by creating technological deployment for **safe zones.** In 2013, Tulsa had a record of 13 pedestrian fatalities, representing nearly one-third of total fatal crashes.

3) Expand the **traffic management center** at the City of Tulsa to include five heavily traveled arterial corridors that also serve two of the proposed Bus Rapid Transit routes.

4) Expand the **Regional ITS Architecture** to include the scope related to future needs such as the planned implementation of Bus Rapid Transit which did not exist at the time of initial adoption in 2006.

Tulsa's Competitive Advantages for Smart City Applications

1) A **one-mile grid network** of streets that allows for potential coordination of traffic on arterial streets with improved traffic management

2) A new **Advanced Traffic Management System** that will be put into service during the next year

3) An **Open Data Policy** adopted by City Council in May 2013

4) Nationally recognized **Cybersecurity center** at the University of Tulsa

5) A **Bus Rapid Transit** (BRT) system in the design stages that could incorporate Mobileye technology and potentially driverless technology in the design phase

6) Tulsa elected officials have embraced shared-use transportation services like Uber and Lyft

Visioning Tulsa's Approach

Vision Element	Tulsa's Approach	Tulsa's Unique Assets
Urban Automation	Prepare 40 linear miles of the city for autonomous vehicles using LIDAR mapping; Prepare regulatory framework for autonomous vehicles	A grid network of streets allow for a more simplified mapping framework. A planned BRT system could be designed with autonomy in mind
Connected Vehicles	Utilize ODOT's and the State's OneOklahoma fiber network with DSRC on major corridors to create a connected network	State of Oklahoma's OneOklahoma fiber network along all state highways; public & private network presence across the City
Sensor-based Infrastructure	Use system developed by the Great Plains Transportation Institute to monitor pavement condition in connected vehicles with built-in accelerometers, feeding back to the ODOT fiber backbone	Partnership with North Dakota St. University and the State of Oklahoma's OneOklahoma fiber network along all state highways
Urban Analytics	Tulsa is poised to collect massive amounts of data where we have been lacking in the past. Adding real-time traffic monitoring and performance measurement will enable better decisions on road reconfiguration options	Tulsa has an established supercomputer supporting academic and government analytics
User-Focused Mobility	Focus on two corridors (Peoria Ave. and 11th Street), where two BRT lines are planned to create "car-free" zones for residents living & working in the corridors	One BRT line is funded and another is anticipating voter approval in April 2016
Urban Delivery	Demonstrate smart delivery systems using new Macy's Distribution Facility	Massive $170 million Macy's fulfillment center opened August 2015 ships orders nationwide. Largest fulfillment center in U.S.
Strategic Business Models & Partnering	Partner with Code for Tulsa brigade to create open data sources for third party applications using traffic data	Existing innovation to enterprise model as a business incubation center
Smart Grid & EV	Integrating EV charging stations into street design and parking lot design	Oklahoma has led in alternative fueled vehicles & infrastructure (primarily natural gas)
Connected, Involved Citizens	Code for Tulsa brigade, a partner on this grant, has a mission of making data more accessible to the general public	Code for Tulsa has been recognized nationally with Champions of Change awards from the White House
Architecture & Standards	Update the existing Tulsa ITS Architecture to include new BRT, ped/bike signals and counters along with the new TMC	Bus Rapid Transit in the design phase and is an opportunity to standardize data available to the public
Secure, Resilient ICT	Demonstrate potential security threats and ways to ensure personal data is secure and mechanical takeover is not possible	University of Tulsa Cybersecurity Center recognized by NSA as Center of Excellence
Smart Land Use	Tulsa's new zoning code will allow technologies to be leveraged to create car-free or car-lite zones with mixed-use zoning to support transportation investment	New zoning code adopted January 2016 enables dense, mixed-use buildings

III. Portrait of Tulsa: Characteristics for the Smart City

In 2015, Tulsa was ranked as the 4th best city in which to start a business by Kiplinger while

WalletHub ranked Tulsa as the 2nd best. Tulsa continues to build on a reputation of attractiveness both for businesses and new residents. Tulsa's Young Professionals, now a 10 year old organization is one of the largest young professionals organizations in the U.S. with over 8,000 members.

Tulsa has withstood the downward growth trend of some other core cities that declined over time, and has not lost the ground as the city reinvented itself with each economic cycle. In 2010, the City of Tulsa embraced a new vision for the city with a major update to its Comprehensive Plan.   The plan identified specific strategies for land use, housing, transportation, environment, and sustainability goals. Over the past five years, the City of Tulsa has funded a Bus Rapid Transit line and overhauled its zoning code to bring Tulsa up to date on best land use practices.

Tulsa's Demographic Snapshot

Metric	Value
City of Tulsa 2010 Census Population	391,906
Population Density per square mile	1,992
Urbanized Area Population (2010)	655,479
Tulsa's proportion of Urbanized Area	59%

Agencies that have embraced technology in Tulsa region include:

Tulsa City-County Library
Tulsa Community College
Tulsa Regional Hospitals
University Systems, two public and one private university
Department of Public Safety, Troop B
Oklahoma Department of Transportation Division 8
City of Tulsa Traffic Operations
Metropolitan Tulsa Transit Authority (MTTA)
Tulsa 911
Tulsa International Airport
Tulsa Port of Catoosa
Tulsa City-County Health Department
INCOG (the MPO)

IV. Tulsa's Environment for Smart City Concepts

Tulsa's population is diverse, but readily accepts innovative solutions to transportation problems. A group of young professionals took the initiative to bring Uber to Tulsa in a short time. The engagement of young professionals and the needs of growing, aging population and the anticipated service delivery for all people of Tulsa without the digital divide provides the ground for the Smart City concept.

Existing Transportation System Characteristics

Category	Measure / Characteristic
Arterial Miles	338 miles (within City of Tulsa)
Freeway Miles	154 miles (within City of Tulsa, all operated by ODOT)
Transit Services	17 fixed routes operating 6 days/week; Approx. $18 million annual budget; 3 million riders per year; Pending dedicated transit tax (April 2016); Funded Bus Rapid Transit (construction in 2019)
Shared Use Mobility Services	Uber & Lyft operate in the Metro area. Both were brought to Tulsa by Tulsa's Young Professionals #BringItToTulsa campaign. Both have been embraced by city council and the Mayor's office.
Information & Communication Technology	Oklahoma OneNet fiber optic network throughout ODOT system.
ITS & Field Equipment	• New Advanced Traffic Management System coming online in 2016 • Econolite Centracs ATMS paired with Cobalt ATC field controller • Rolling out new controllers on 25 miles of arterial streets in 2016 • V2I technology built into Centracs ATMS and Cobalt ATC
Smart Grid/ EV Infrastructure	• The City of Tulsa has 6 EV charging stations open to the public. • Public Service Company of Oklahoma has implemented Smart Meters in all their residential properties

Continuity of Committed Leadership

Tulsa's political and administrative leadership has been very stable over the past several years. City officials have taken steps to make embrace an Open Data Policy, work with local civic coding brigades, and even setup a committee of local coders to work to make more data open to the public.

The Sharing Economy

Tulsa not only embraces the sharing economy but actually encourages it. In 2013, Tulsa's Young Professionals (TYPros), conducted a #BringItToTulsa campaign that sought out Uber to bring the service to Tulsa. The Tulsa City Council supported this effort and created an

agreeable regulatory framework for Transportation Network Companies like Uber and Lyft. Tulsa continues to welcome the sharing economy, especially in the transportation sector to enable more transportation options and create ladders of opportunity.

Commitment to Open Data

Over the last several years, the City's website has received the highest A+ rating from the Sunshine Review organization for government transparency. In 2013, the City of Tulsa adopted an Open Data Policy as a partnership with Code for Tulsa, an official brigade of Code for America. These local civic technologists and the City have joined forces to identify opportunities to share data in easily accessible formats. This effort also is overseen by a public/private steering committee to develop goals and implement programs. In this first step, we have identified key public information that is readily available and posted links on this page to make it easier to find.

Public Transportation

The Metropolitan Tulsa Transit Authority, also known as Tulsa Transit, is a public trust of the City of Tulsa. Tulsa Transit operates local scheduled bus service as well as the paratransit system in City of Tulsa and provides services to suburban communities on a contract basis. MTTA will be the leading entity implementing the Peoria BRT project. Service frequencies for 17 daily fixed routes range from 25 minutes to over 60 minutes. Tulsa Transit operates two major transit centers: the Denver Avenue Station (DAS) in downtown Tulsa, and the Memorial Midtown Station (MMS).

On January 28, 2016 the Tulsa City Council passed a resolution to put before the voters a permanent funding source for public transportation. This is the **first permanent public transportation funding proposal in Oklahoma history**. If the tax is passed, an additional $57 million for capital and operating investment will be available. It will fund a second Bus Rapid Transit corridor operations connecting major employment centers in the city.

Tulsa Regional Architecture Background and Implementation

Tulsa Regional Architecture was developed as a coordinated effort among the Oklahoma Department of Transportation, Department of Public Safety, Tulsa 911, INCOG (the MPO) and City of Tulsa.

The following figures illustrate the status of Tulsa Architecture that is developed for implementation over the time period. Over the last decade, the effort primarily focused on existing entities, existing flows as well as emerging connections.

The identified goals of Tulsa ITS Concept of Operations include:

- Improve the overall safety and security of the transportation network

- Improve interagency information sharing and increase operating and responding agency efficiency

- Establish and develop regional traffic management strategies and practices

- Establish a regional incident management system

- More effectively disseminate traveler information to the traveling public

- Promote the use of transit and alternative modes with reliable information on travel choices
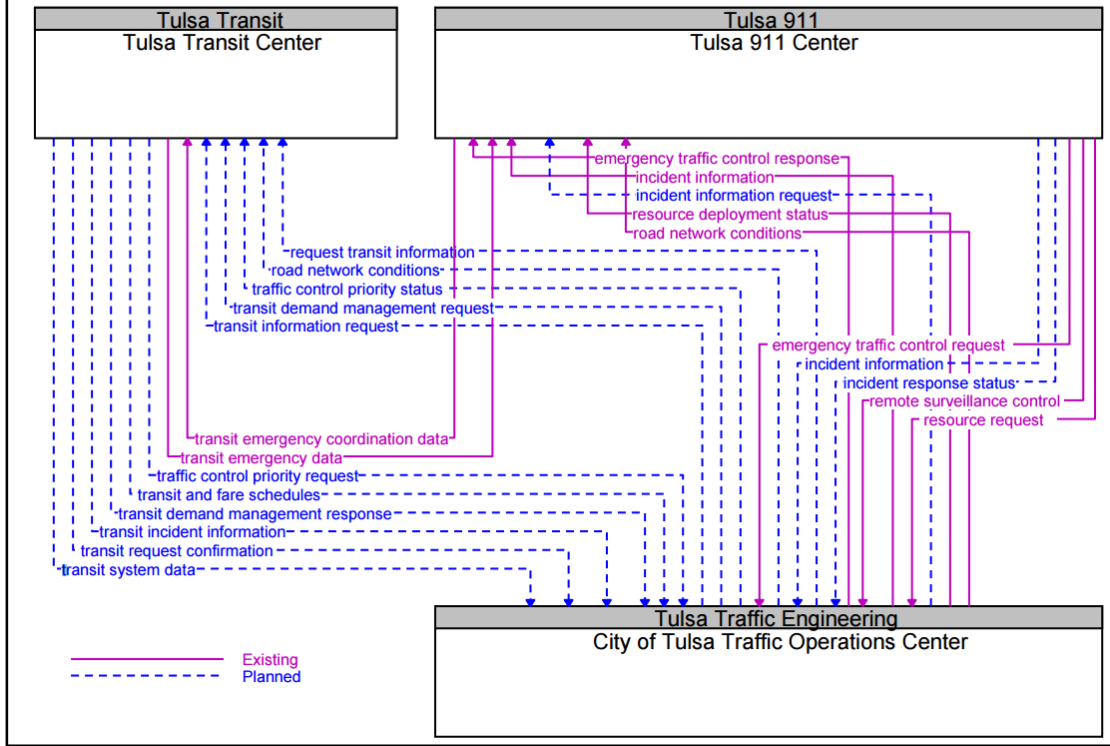
Performance targets for Tulsa ITS
Tulsa implementation plan identified the mission for Tulsa ITS as below:
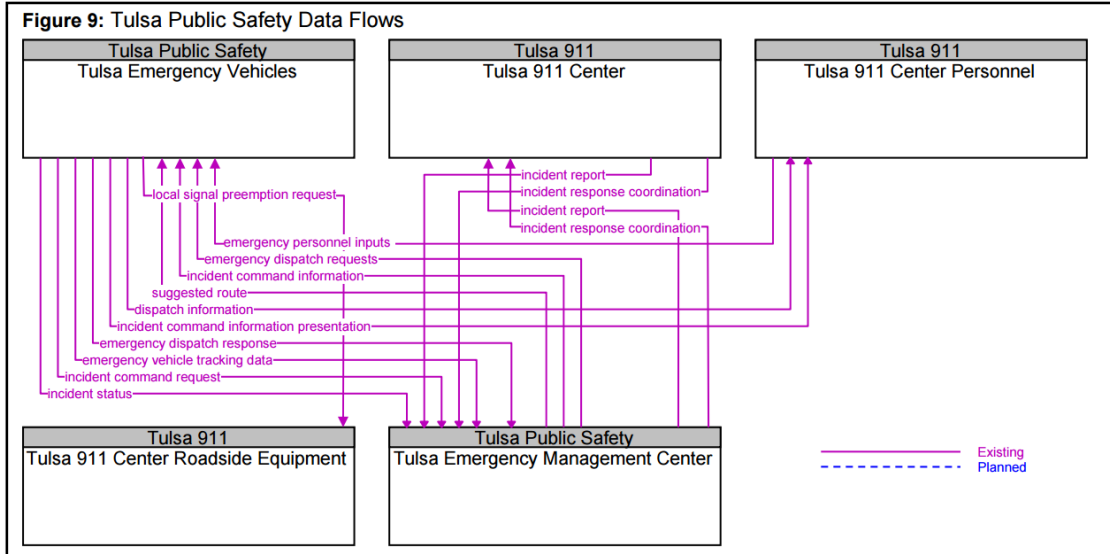
- Reduce response, identification and dispatch time for incidents to two minutes (a 30% reduction)

- A 23-minute reduction in incident duration, resulting in cost savings of $44.6 million due to reduced delay time

- A 2.3 benefit/cost ratio for freeway and incident management components (based on a capital investment of $72 million for these improvements)

- Other non monetized benefits to realize include, air quality impact, fuel consumption and accident/stress reduction and more efficient use of emergency services and satisfied travelers.

Portions of Tulsa regional ITS architecture are shown on the following page.

Figure 5: Tulsa Data Flows

Tulsa Transit	Tulsa 911
Tulsa Transit Center	Tulsa 911 Center

emergency traffic control response
incident information
incident information request
resource deployment status
road network conditions

request transit information
road network conditions
traffic control priority status
transit demand management request
transit information request

emergency traffic control request
incident information
incident response status
remote surveillance control
resource request

transit emergency coordination data
transit emergency data
traffic control priority request
transit and fare schedules
transit demand management response
transit incident information
transit request confirmation
transit system data

Existing
Planned

Tulsa Traffic Engineering
City of Tulsa Traffic Operations Center

Data Flows for Tulsa ITS Architecture between Transit, Traffic and E911

Figure 9: Tulsa Public Safety Data Flows

Tulsa Public Safety	Tulsa 911	Tulsa 911
Tulsa Emergency Vehicles	Tulsa 911 Center	Tulsa 911 Center Personnel

local signal preemption request

incident report
incident response coordination
incident report
incident response coordination

emergency personnel inputs
emergency dispatch requests
incident command information
suggested route
dispatch information
incident command information presentation
emergency dispatch response
emergency vehicle tracking data
incident command request
incident status

Existing
Planned

| Tulsa 911	Tulsa Public Safety
Tulsa 911 Center Roadside Equipment	Tulsa Emergency Management Center

Tulsa ITS Data flows among Public Safety agencies & personnel

## V.   Tulsa Beyond Traffic & 2045: Reimagining Travel

Needs Analysis

The City of Tulsa experiences non-recurring congestion predominantly that is related to incidents resulting in unpredictable travel times. The traffic delay heat map will show spot based congestion that is predominantly intersection-based and/or incident related. Many local and state agencies over the past decade worked to pass quick clearance legislation that enables the responding agencies to quickly identify and clear the vehicle hazards to keep traffic moving.   The ITS implementation plan recognizes the need and makes recommendations related to improving flow.
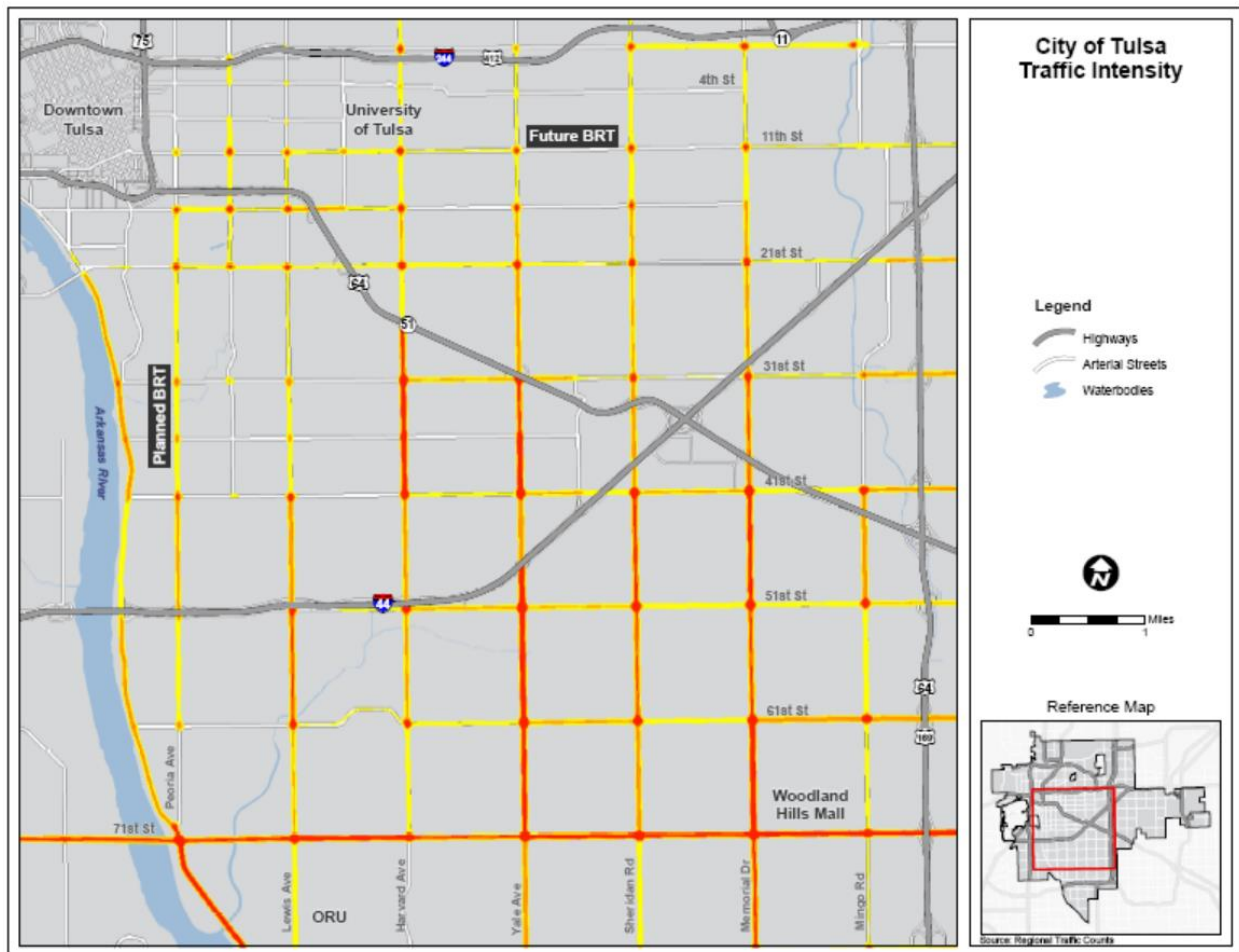
Schematic of spot congestion during peak hours

Tulsa Tomorrow: 2040 Planning

The goal of the adapted ITS strategy is to relieve the congestion and improve predictability in travel times for all modes of travel. The goals are to eliminate the secondary crashes and improve signal timing strategies in such a way as to achieve meaningful differences in travel behavior, starting with specific heavily traveled arterials.
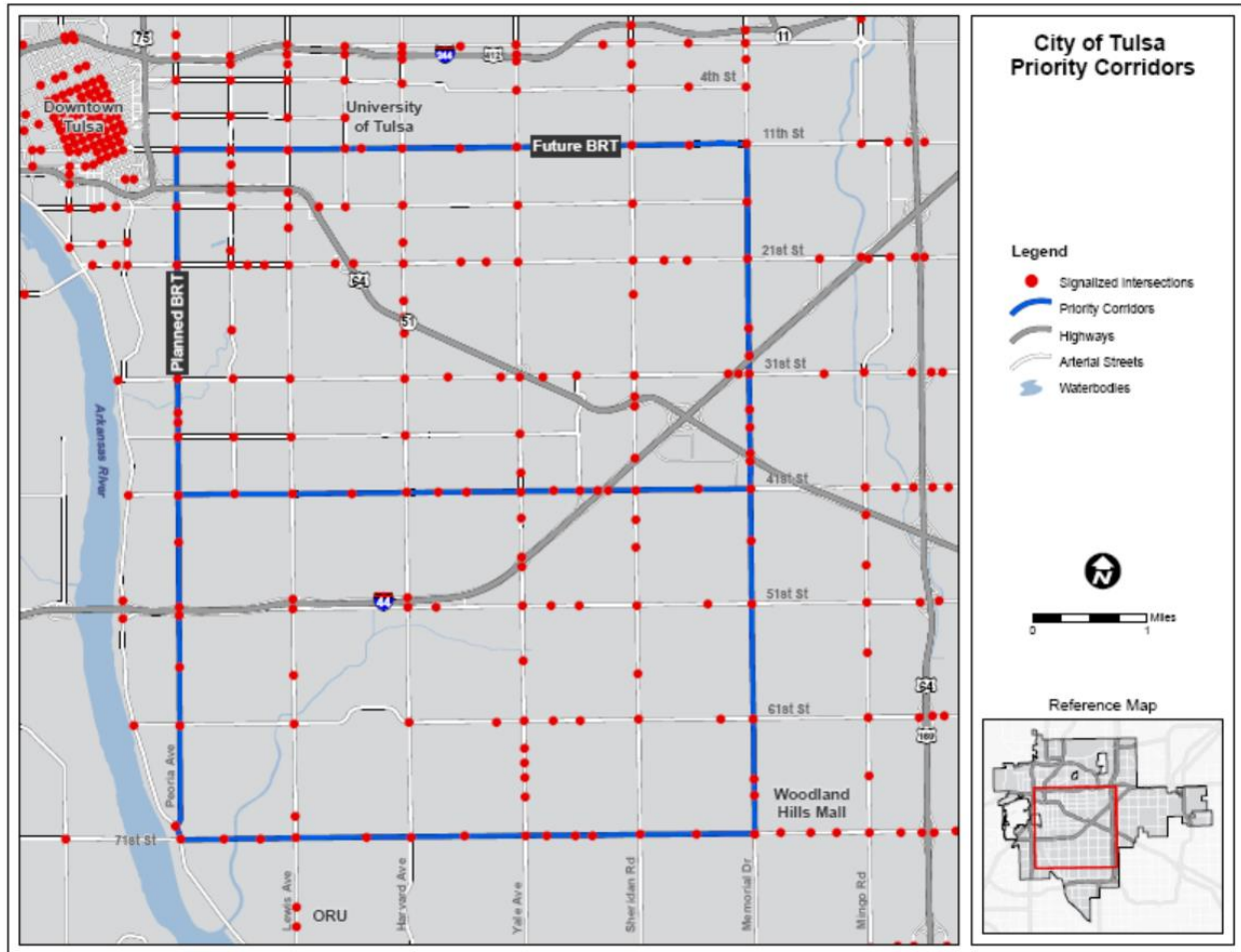
City of Tulsa Priority Corridors for Signal Optimization and Traffic Management

Intelligent Transportation Systems: Elements of Next Phase

Tulsa's Regional ITS Architecture mapped all the elements and subsystems sufficiently that has served the purpose of planning and implementation during the elementary stage. Working to go beyond the initials step requires systematic planning approach and strategic investment. The smart cities opportunity provides for such a framework, to reimagine the ITS within the context of achieving the second stage of public acceptance and adaption.

Beyond traffic, personal travel depends on safety, risk factors and predictable travel times. The smart city approach for the City of Tulsa is to integrate systems planning into the signal integration and safety planning for all modes.
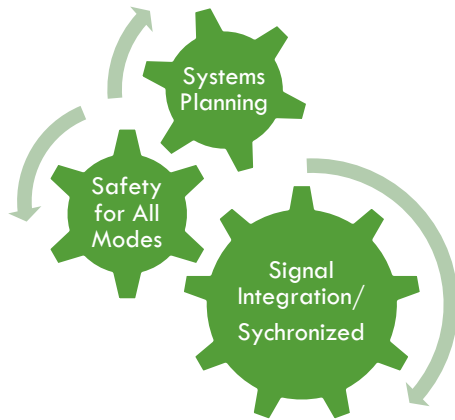
Focus on Safety

This grant proposal is aimed at **cutting crash rates in half within the thirty year period**. It is achieved by linking systems inside of city of Tulsa, personal, vehicular and street systems altogether to prevent crashes.

- The proposal will involve requiring all vehicles sold and used in Tulsa to have **crash prevention systems** enabled and working by 2045.

- The proposal enables drivers with **personalized travel information** with expected delays, potential alternates with push-technology based on algorithms designed for time and day.

- The proposal will enable all vehicles used in Tulsa to safely **self-park by 2045.**

- The proposal will enable a personal device such as a smart phone to **alert pedestrians and drivers simultaneously** to the nearest safe crossing zone and alert the drivers.

- Employ smart transportation system that learns from the events around it and adapts to the needs of the users: Transit agency is updated daily and hourly with various activities in the city, from conventions to classes at the libraries & community colleges and therefore will adapt to the changes of travel desires of users by changing the service delivery. **These changes will be proactively communicated to the groups that are the patrons of the system.** The system uses customized, tailored transportation for each user segment of the system (Example: The downtown convention on smart cities has changed by 15 minutes hence the delegates can take the BRT route that is extended to suit the hours of the convention - a user driven system operation).

- Traffic signals will have been synchronized to automatically sense an ambulance approaching not based on the action by the ambulance driver and automatically adjust the safe route to hospital corridors to provide optimal time to travel.

Many such scenarios can be envisioned because of two reasons:

1. The transportation policy officials have recognized the vision-zero or a zero fatality concept embraced by the City of Tulsa; and

2. The recently concluded Mayor's Transit Governance & Funding Task Force stated the desire to create a better transportation delivery options within the City.

The City of Tulsa realizes at that any smart city investment should include safety as a cornerstone in order to optimize the return on investment. No city can continue to have the same fatality rates and can claim to be smart on its part. Therefore, City of Tulsa proposes to invest in such infrastructure to enable it to achieve the goal by the year 2045.

Data Collection and Analytics Opportunities

The City of Tulsa has an Open Data policy adopted in 2013. The commitment to open data and the local presence of a Code for America brigade is strong in Tulsa.

Currently Collected Data

Data	Who collects	Benefit w/ Smart Cities	Public?
Traffic counts	City of Tulsa Traffic Engineering	Could increase traffic counts to real-time data, instead of annual counts	YES
Transit ridership (by route)	Tulsa Transit	Adding automatic passenger counting systems could create a more efficient routing structure	NO
Ground Level Ozone	Oklahoma Department of Environmental Quality	Ozone monitoring levels could be directly connected to VMT and tracked in tandem	YES
Crashes	Tulsa Police, Oklahoma Hwy Patrol	Crash data could be correlated with speeds and compared with	YES

Additional Data Tulsa Could Collect w/ Smart Cities Challenge

Data	Who Would Collect	Benefit	Public?
Real-time travel speeds on arterial streets	City of Tulsa Traffic Operations Center	Patterns of congestion could be predicted and disseminated to the public, freight shippers, and businesses	YES
Traffic incident response status	City of Tulsa Traffic Operations Center	Could be communicated to media and disseminated through connected vehicles to notify of reroute possibilities. Clearance time could be targeted and tracked over time	YES
Transit boardings and alightings by location & time	Tulsa Transit	The public could make recommendations on transit service improvements and suggest changes through an open, rolling process	YES
Bicycle and Pedestrian Counts	City of Tulsa Traffic Engineering	Better understand bicycle and pedestrian travel to inform local decisions and	YES
Comparison data on travel time across modes	Tulsa Transit, Traffic Engineering,	Enable a cross-mode transportation platform that combines the cost and time of travel by mode based on real-time travel conditions	YES

Terms & Conditions on Data Sharing

The City of Tulsa intends to make as much data as possible accessible to the public. Our Open Data Policy adopted in 2013 requires us to share as much data as possible with the public, in and open standards format. We have also established a committee of local volunteers to aid in moving this policy forward over the past two years.

VI.   The Smart City Project Objectives

Improve Traffic Operational Efficiency
- Comprehensive regional communication strategy to share information related to data from various agencies and sources.

- Traffic Engineering (TE) Division improves the overall traffic experience by extending the scope of data used to analyze traffic patterns, leveraging real-time data, applying adaptive analysis and sharing data with the public.

- INCOG will establish a data exchange mechanism to acquire appropriate data as well as create and standardize analysis procedures to quantify traffic problems, evaluate alternatives and prioritize projects and funding allocations.

- Improve cooperation among governmental agencies and citizens, the region will seek to establish a communication and engagement strategy based on shared data, analysis and reporting.

Improve Transportation Safety
- Improving overall communications to help reduce the lag between improvements in transportation safety outcomes and perceptions of public and private transportation

- Apply data analytics to existing youth services data to identify key risk factors using aggregate data sets, proactively identify high-risk individuals using those risk factors and other key attributes and track and measure outcomes of intervention strategies.

User Responsive Transit
- Transit agency will adapt a technology to be deployed within the FOUR smart corridors identified, the TWO BRT corridors and two heavily traveled arterial corridors, to respond based on the user base, learning institutions, and conventions to automatically use a real time information to change the service schedule and times.

Improve Air Quality and Resiliency
- Reduce emissions related to Automobile Travel

- Analyze data at the regional scale and track progress

- Provide data to residents with a personalized travel information at an individual and household level regarding the Vehicle Miles Traveled (VMT) and Hours (VHT) spent in congestion to make intelligent choices related to selection of modes of travel.

<u>**Smart Governance with Systems Integration**</u>

- Eliminate duplication and implement integration of systems to provide optimal solutions for efficient organization of systems.

- Governments must transform not only the way they think about themselves and how they deliver services, but also the manner in which technology can enhance their engagement with citizens.

<u>**Bridge the Quality of Life Divide**</u>

- Improve the overall quality of life within the city by bridging the divides within the city

- Address physical and economic barriers and ways to overcome the historical legacy

- Evaluate infrastructure parity, human capital development, education, neighborhood affordability, homelessness and economic development opportunities

- Analyze the interconnectivity of the social service infrastructure with an overarching city strategy

VII.   Elements of Tulsa's Smart City Vision

<u>**Public Transportation**</u>   **VISION ELEMENTS #3, 4, 5, 9, 10**

With funding from the Smart Cities Challenge, Tulsa will create an **open data platform** to make it easier and more efficient to operate the transit system. Adding automatic passenger counting systems will make for better management decisions and adding technology to make the system more user-friendly.

Opportunity exists to build in smart principles to a new **multi-modal transit hub** (pending approval April 5 by Tulsa voters). By creating transit hub that integrates fixed route transit, ridesharing platforms (Lyft/Uber), car rental (Zip Car/Hertz Local), bikeshare, and intercity buses, Tulsans can more easily understand their travel options. A combined payment system, or integration with smartphone payment system like Android Pay or Apple Pay, makes it even easier to take a bus/Uber combination trip and analyze the difference in cost between driving alone and taking transit.

Over the next three years, Tulsa Transit, will develop a **bus rapid transit system** along the Peoria Avenue corridor, to replace a transit route which currently has the system's highest ridership. Through the proposed bus rapid transit corridor, multimodal service will be enhanced within high-capacity segments of Tulsa's transportation network. It is expected that the bus rapid transit route will operate at a 15-minute frequency during peak hours and a 20-minute frequency at other times. Buses will be given traffic signal priority to remain on schedule. Additionally, each of the route's 36 stations will include security lighting, real-

time arrival screens, new sidewalks and enhanced pedestrian crossings. It will be critical to link these technologies with emerging mobility platforms so that transit users can use ridesharing, bikeshare and intercity bus seamlessly. The Smart Cities Challenge grant will ensure this integration occurs.

By enhancing connectivity among neighborhoods within the City of Tulsa, the Peoria bus rapid transit will enhance mobility for people who currently have limited transportation access. Once built, the approximately 15-mile-long corridor will connect Downtown Tulsa with a variety of retail districts, college campuses, employment centers and social services. The Peoria Avenue bus rapid transit route is strategically located, as **20 percent of Tulsa jobs, and one in seven Tulsa residents, are within a ten-minute walk** from a station along the corridor. Additionally, the route will directly serve economically disadvantaged neighborhoods where automobile ownership is low, and provide these neighborhoods' residents with efficient transportation access to jobs and education opportunities.

It is also likely that the bus rapid transit corridor would contribute to shifts in travel patterns citywide, and eventually contribute to reduced vehicle emissions and reduced vehicle miles traveled. With this in mind, the bus rapid transit corridor could also be an effective approach to address the broad challenge of climate change and mitigate the local congestion that would arise from Tulsa's forecasted population growth.

Integrating Land Use   *VISION ELEMENT #12*

The City of Tulsa understands the importance of integrating a city's land use policy and transportation infrastructure, and has been committed to smart land use, especially in recent years. Tulsa's commitment to smart land use is most notably evident in its **new zoning code**, effective January 2016, as well as in the transit-oriented development it will pursue on a Bus Rapid Transit corridor now in development.

A new zoning code was adopted by City Council in November 2015 and it went into effect this January. Ultimately, the new zoning code makes it easier to support and attain the goals presented in Tulsa's Comprehensive Plan. For example, the new zoning code is conducive to frequent public transit service, and aims to enhance the variety of Tulsa's transportation options through streets that not only support automobile use, but are also pedestrian-and-bicyclist-friendly. In this sense, the City of Tulsa's new zoning code can lead to safer streets for pedestrians and bicyclists, and make the city's transportation network safer for all who use it.

The zoning code also emphasizes how land use and transportation are closely intertwined. Through establishing special districts and corridors, the code intends to encourage development patterns supportive of multimodal transportation and increase usage within segments of the transportation network where capacity is comparatively high. By focusing

especially on these high-capacity segments, the City of Tulsa can make its transportation network even more efficient.

With a new zoning code recently implemented and a bus rapid transit corridor on the horizon, Tulsa is positioning itself to make groundbreaking advancements in transportation infrastructure. When it comes to ensuring that Tulsa's transportation network is effective and efficient, maintaining smart land use is among the beginning steps. Yet in order to make Tulsa's transportation network as great as possible, we need to combine smart land use with the latest transportation technology. Through technologically-driven approaches, Tulsa can build upon its current successes and take its transportation infrastructure to the next level, enhancing livability, sustainability, and mobility for Tulsa residents citywide.

Clearing the Path for Autonomous Vehicles *VISION ELEMENT #1*

Tulsa has a unique potential implement autonomous and connected vehicle technology. By leveraging the existing one-mile grid street network, and mapping an area of the city with LIDAR, the city could potentially create an **"autonomous vehicle zone"** of 10-20 square miles to allow trips within that district to be handled by autonomous or semi-autonomous vehicles (SAE Level 3).

This technology could also be integrated into Tulsa's new Bus Rapid Transit system, currently in the design phase. At a minimum Mobileye technology could be deployed on the fleet, but perhaps a SAE Level 2 or 3 autonomy could be **built into the buses being delivered** as part of the BRT system. Tulsa could be a showcase of this technology and prove the value of reducing the operating cost for transit by as much as 70% due to reduced labor costs.

Connected & Efficient Freight *VISION ELEMENT #6*

The Tulsa metro is located on one of the most important freight corridors in the United States. Freight is transported through multi-modal facilities. Over the road truck traffic is primarily along I-44 and I-244. For rail traffic, two major Class I railroads: UP and BNSF. A majority of this freight is containers and coal. As Oklahoma is a major crude oil producing state, railroads and trucks transport a large amount of crude and refined oil through Tulsa. Tulsa also has an inland waterway port, the Port of Catoosa which is located at the head of McClellan-Kerr Arkansas River Navigation System. The bulk freight handled at the Port of Catoosa includes fertilizers, industrial gas, wheat, and consumer goods.

With this multi-modal transportation network, Tulsa provides a unique opportunity to test Vision Element #6: Urban Delivery and Logistics. Connecting these three modes of transportation could demonstrate a more efficient freight network. The utilization of Freight Advanced Freight Traveler Information System (FRATIS) can be demonstrated using this connection. The optimized network will generate a time savings and reduced cost of freight delivery.

Tulsa provides an opportunity to test **truck safety applications.** Tulsa already has cameras on major highways and they are connected to the ODOT information center with fiber optic network. This network will be used to implement the **dynamic truck signs** and **dynamic road signs** based on the inputs from the cameras and sensors on the bridges.

Macy's Fulfillment Center, Tulsa, OK (Opened August 2015)

Tulsa boasts a new Macy's Consumer Fulfillment Center, opened in 2015. This is Macy's largest fulfillment center, handling over 325,000 orders per day. This facility handles two different types of truck traffic: inbound large semi-truck and outbound small delivery trucks. This facility can be used to **test connected vehicles and optimize the delivery schedule.** The connected semi-truck can send information about arrival at the facility and the small delivery trucks can dynamically schedule based on the arrival information from the semi-truck. Also information about truck parking situation can be transmitted to the inbound trucks thus reducing congestion at the facility and street network leading to the facility. This can be also be used to test the consolidation center strategy. As smart cities application encourages partnerships between public and private institutions, this partnership between City of Tulsa and Macy's can be a good example of this approach.

The City of Tulsa also has several plans of road diets so some of the streets can be tested for **dynamic delivery timings** and parking as there will be less space for commercial delivery vehicles. This will also help to **reduce the idling time** of the trucks and reduce fuel consumption and emissions.

Climate Change Challenges for a Smarter Tulsa
Tulsa's proposal seeks to optimize efficiency by choosing to invest in transitioning to electric vehicles through infrastructure, compact land use, public transit and efficient personal and freight movement in the region.

Primary Implementation Phase

1. **Long term local vulnerability mapping:** INCOG, the Metropolitan Planning Organization for the Tulsa region is committed along with the state and federal

partners to conduct a comprehensive vulnerability assessment for the region using the FHWA's vulnerability assessment framework. The computing resources identified as a part of this grant application will be used to analyze data sets along with local temperature and precipitation projections to assess scenarios for future in order to assess the vulnerabilities.

2. **Compact Land Use**: The City of Tulsa's new Zoning Code went into effect beginning January 1st, 2016. The Code allows for no parking to significantly reduced parking in high density transit-rich corridors. The carbon footprint along these corridors will be measurable, since these corridors also aligned with the previously funded implementation of Bus Rapid Transit (BRT).

3. **Synchronized Corridors**: Smart Corridors of Signal Transition: City of Tulsa a for long time has planned to implement progressive signals and adaptive signals along significant arterials. The attached map shows the corridors that carry over 40,000 vehicles per day. Each of these corridors will have an increased throughput with the implementation of coordinated signal system.

4. **Park once zones**: The City of Tulsa will increase alternative transportation means, bike and walk options, with quadrupling of the sidewalks, trails and on-street bikeways with the implementation of the GO Plan, the newly adapted bike, pedestrian master plan.

5. **Corridors of Choice**: The City of Tulsa can extend the implementation of alternative fuels technologies that reduce the carbon footprint, along with electric vehicle charging stations targeted along the smart corridors.

6. **Real-time Freight Planning**: Identifying freight routes and enabling shippers along with real time information related to non-recurring congestion can help reduce idle time and lost productivity thereby reducing emissions.

VIII. Key Risks & Mitigation Strategy

A vision for a city to enable a smarter delivery of traffic enabling services at an affordable cost contains certain inherent risks. Mitigation methods must also encompass smart technologies and deploying resources in a strategic manner.

Technical Risks

1. Technology risk - availability and life cycle costs of limited use, prototype technologies can be a risk to realizing the timeline for a proposed smart city project implementation.
2. Cost risk - budget is always a concern and consideration. A planning level estimate would include thirty percent contingencies while a 15% design level contingency would help to mitigate the cost overrun risk.
3. Timeline risk - for a public project to be implemented with federal resources, many state and local partners the risk related to timeline can be reduced with appropriate levels of staff involvement across multi-disciplinary teams as a steering committee

Policy Risks

A potential policy risk is not having enough buy-in from the public. This particular risk is mitigated with an overwhelming number of households in Tulsa using smart cards in the form of smart tags for turnpike usage. This shows the adaptive nature of the smart tag use in system implementation.

Another potential policy risk is lawmaking regarding autonomous vehicles, if that is ultimately part of the program. The State of Oklahoma will likely have to pass legislation to allow autonomous personal or transit vehicles.

Institutional Risks

Silos in Government - Local, state and federal governments tend to have niche expertise living in silos created for a particular purpose. Creating innovative uses for such expertise in government at all levels will be the key to bridge across the platforms with multi-disciplinary teams helping to resolve and mitigate many such risks. The City of Tulsa has shown a consistent performance in such areas of challenge, whether it is to work toward creating Context Sensitive Solutions or to reach the goals through a sustaining effort to build coalitions from bicycle, pedestrian and transit groups involving the MPO.

IX. Key Partners

The City of Tulsa has put together an impressive list of partners to ensure that the Smart Cities grant will succeed. Our partners have success locally, nationally and globally addressing technology issues around transportation.

Summary of Partners & Roles

Partner Name	Key Role	Vision Element
100 Resilient Cities	Policy & regulatory guidance	1, 2, 4, 5, 7, 9, 12
City of Tulsa Traffic Engineering	Implementation & Traffic Management Center	All
Oklahoma Innovation Institute	Houses the Tandy Supercomputer, critical to urban analytics	4, 7, 10
University of Oklahoma Wireless Electromagnetic Compatibility & Design Center	Design of hardware and compatibility. Standards and system architecture	1, 2, 3, 10
University of Tulsa Institute for Information Security	Cybersecurity	11
Tulsa Police Department	Implementation of efforts by Police Officers	7, 11
North Dakota State University	Pavement condition monitoring and data collection	2, 3, 4, 10
INCOG (MPO)	Intergovernmental coordination and regional implementation	12
Code for Tulsa	Engaging citizens and creating crowdsource platforms	9, 10

Oklahoma Innovation Institute Tandy Supercomputing Center

The Tandy Supercomputing Center (TSC) provides dedicated and shared cyberinfrastructure resources, expertise, and education to students, faculty, and staff at its members and the community at large. TSC is an initiative of the Oklahoma Innovation Institute (OII), a 501(c)(3) not-for-profit corporation based in Tulsa, OK.

As a core computing facility for Oklahoma State University-Tulsa, the University of Oklahoma-Tulsa, Tulsa Community College, Oral Roberts University, and The University of Tulsa, TSC not only collaborates directly with researchers to apply high performance computing (HPC) to their specific investigations, but also educates faculty, staff, and especially students in the use of that cyberinfrastructure.

The majority of the infrastructure, including the space, power and cooling equipment, and networking equipment are funded by OII through private philanthropic contributions and through a completed Economic Development Administration grant (EDA #080104715, "Tulsa Community Supercomputer," $800,000).

TSC provides dedicated computing resources to its members on its tightly coupled, 34.4 TFLOP/s Linux cluster, the Tandy Community Supercomputer ("Tandy"). Tandy has an aggregate peak speed of 34.4 TFLOP/s; 1600 total cores; and 12,800 GB of RAM. Tandy consists of 100 compute nodes (expandable to 324 with no additional infrastructure), each of which has 128 GB of RAM, dual Intel Xeon E5-2680 8-core 2.7 GHz CPUs (16 cores per node).

TSC is connected to the OneOklahoma Friction Free Network (OFFN, pronounced "often") at 20 Gbps (2 bonded 10 gigabit Ethernet optical connections). OFFN is a high-speed dedicated research network connecting the significant computing facilities at TSC, the University of Oklahoma, Oklahoma State University, Langston University, and (pending NSF approval) the University of Central Oklahoma. OFFN is designed to take advantage of software defined networking (SDN), facilitating end-to-end management, by researchers, of high bandwidth/high performance data flows through a distributed hierarchy of open standards tools (NSF #1341028, 10/1/2013-9/30/2015, $499,961.00, PI: Neeman).

Urban Analytics Capability

Analytics can be applied over a number of planning horizons, not just real-time, to study travel patterns, validate and calibrate transportation and travel models, analyze corridor operations, measure mobility and reliability performance, understand traveler behavior, and develop travel demand management policies.

The Tandy Supercomputing Center has a broad mission to serve the Tulsa community. Leveraging open city datasets, project datasets from connected vehicles and roadway sensors, and other community data sources, TSC resources can provide the compute infrastructure to enable new analytical capabilities. A community supercomputer is a competitive advantage for the city in these analytics.

TSC is capable of serving as a hub for community data and analytics, enabling (1) academic researchers from its member institutions to innovate using transportation data; (2) private sector companies to have a low-cost shared resource to impact Tulsa's economy with innovations in urban analytics, and (3) the community to access datasets that may not be appropriate for other repositories.

University of Tulsa Institute for Information Security (iSec)

The University of Tulsa's (TU's) Institute for Information Security (iSec) is a multi-disciplinary program of study and research tackling cyber security issues on a global scale. TU has established itself as one of the leading schools in the country for information security research and education with more than a decade of experience in the field. The institute is expanding relationships with the government and the private sector, enhancing opportunities for TU faculty and students to address real world information security challenges.

National Security Agency Center of Academic Excellence

Information Assurance Education (2000)

Information Assurance Research (2009)

Cyber Operations (2012)

In May 2000, the National Security Agency (NSA) designated TU as a Center of Academic Excellence for Information Assurance Education. In May 2009, the NSA designated TU and iSec as one of the new Centers for Academic Excellence for Information Assurance Research. Finally in May 2012, the NSA designated TU as one of four new Centers of Academic Excellence for Cyber Operations making **TU one of only three universities in the country to hold all three designations from the NSA.** The institute's faculty has also spearheaded certifications in all six federal standards for cyber security training from the Committee on National Security Systems Instruction (CNSSI). TU was the first university in the country fully compliant with the federal standards for information security and has awarded more than 900 certifications from CNSSI.

iSec's Industrial Security Program facilitates sensitive private sector and U.S. government research. The Industrial Security Program operates a 6,500 square foot Department of Defense, Director of Central Intelligence Directives 6/9 compliant Secure Compartmentalized Information Facility (SCIF) dedicated to special government research and instruction programs.

While Oklahoma's past is deeply rooted in energy, the state is poised to become a dominant force in information security due to its central location, low cost of doing business, and the high quality of its trained workforce. By providing an educational experience that is second to none, the institute works not only produce the best students in the industry, but also create an environment that presents unbeatable employment opportunities in Oklahoma.

Kinetic Event Reconstruction Laboratory @ Univ. of Tulsa iSec

Consider a scenario where an adversary desires to cripple the transportation sector by commanding as many commercial vehicles to apply full throttle at the same time. Any compromised vehicle on the road would either crash into other vehicles, or the engines would suffer acute mechanical failure from over spinning the engine. If such an event were coordinated, it could even be considered a terrorist attack.

A commercial vehicle is a manifestation of a networked cyber-physical system. It contains computing elements, mechanical elements, and communication elements. Specifically, the embedded engine controller senses inputs (e.g. throttle position sensors, engine loads, vehicle

speeds) and commands mechanical apparatus (e.g. fuel injectors, transmission, etc). Sensors and subsystems are often connected to the Engine Control Module (ECM) using a Controller Area Network (CAN) communicating with standard protocols (e.g. SAE J1939).

The CAN bus manages automotive engine and body control under an efficient multi-master networking capability. The multi-master design allows for streamlined modification and extension of a network by permitting several nodes to act as masters on the system at once. CAN solutions have characteristics distinct from computer networking architectures, and these have serious security implications. The multi-master solution and message-centric arbitration scheme mean that any node on the network could easily impersonate any other node. With respect to the protocol itself, the ability of an adversary to inject, modify, intercept or destroy messages on a CAN system is much greater than that over a corporate information network.

The objective of the research at the Kinetic Event Response Laboratory (KERL) is to develop general frameworks and strategies to detect and mitigate hybrid threats to critical cyber-physical systems. Hybrid threats can be categorized as the ability to apply one or a combination of the following attack methods:

KERL research uses a multidisciplinary team since the elements comprising different cyber-physical systems come from different fields. Successful implementation of the research will lead to safer and more secure processes, infrastructure, and systems – all of which are critical to securing America against more sophisticated attacks.

Secure RFID Laboratory @ Univ. of Tulsa iSec

The Secure RFID Laboratory (SRL) focuses on the development of secure RFID systems. The initial effort is the development of a secure RFID system to screen and monitor cargo containers, and to evaluate the security of existing RFID systems. Such systems can be used as electronic seals or eSeals as specified in the SAFE Port Act of 2006. New secure RFID technology and tools to validate the security of RFID systems will be developed within SRL. The goals of SRL are:

- The creation of the next generation of secure RFID systems.
- Create a facility where government agencies and private industry can access the security and RFID resources of iSec and The University of Tulsa.
- Develop accepted best practices for developing and operating secure RFID systems.
- Develop and deliver specialized courses and seminars on secure RFID systems. This includes traditional college courses and professional/continuing education courses.

Econolite

Econolite is the North American leader in Intelligent Transportation Systems (ITS) and transportation management solutions that enhance roadway safety and mobility. Econolite is one of the companies responsible for the significant technological strides made on the

infrastructure side of the connected vehicle equation. Leveraging DSRC (IEEE 802.11p standard), Econolite's vehicle-to-infrastructure (V2I) solutions help complete the smart driving environment picture through data exchanged between vehicles and infrastructure/roadside equipment (RSE), enhancing multi-modal traffic management.

Econolite's Advanced Transportation Management Systems (ATMS), **recently purchased by the City of Tulsa**, provides the real-time traffic monitoring and control capabilities necessary to support a connected vehicle and Smart City environment. Connected Vehicles require a traffic signal controller that provides SPaT status information through DRSC-based RSE. Econolite's ATMS and traffic controller combined can provide breakthrough smart intersection and traffic control capabilities.

Econolite's V2I solutions under development require a minimum level of infrastructure to provide the highest levels of safety and mobility benefits, including the potential to resolve crash types not addressed by current vehicle-to-vehicle-only applications.

An example of a proven connected vehicle application is the Multi-Modal Intelligent Traffic Signal System (MMITSS), a fully functional intelligent traffic priority signal system operating in an integrated connected vehicle smart driving environment. Econolite Group, Inc., in cooperation with the University of Arizona, and Savari, Inc., have developed a connected solution that actively manages a multi-modal priority signal control system in which priority requests from varying modes of transportation (e.g. emergency vehicles, public transit and freight, all while maintaining coordination) are safely accommodated simultaneously at the intersection using DSRC technology.

MMITSS combines existing V2V and V2I technologies and products to provide a complete smart connected vehicle solution, enabling new levels of intersection safety and efficiency advantages by identifying, prioritizing, and providing safe passage for several simultaneous authorized priority vehicle requests at an intersection, including identifying and providing safe passage for pedestrians.

In addition to currently available connected vehicle products and solutions, Econolite will soon introduce their next-generation ATMS, traffic controllers and data analytics capabilities to help smart cities more efficiently handle changing traffic conditions. These new solutions are designed to significantly expand the operational capabilities of the smart city environment by leveraging the real-time data exchanges of connected and autonomous vehicles to optimize traffic flow and safety.

The MyHealth Access Network: A proven success story of statewide IT integration

In 2010, Tulsa launched one of the most ambitious architecture and standards in the healthcare sector. This story serves as an example of how Tulsa has successfully integrated many disparate IT systems across the state to enable health care providers to effectively manage patient information in a secure environment. The effort was funded by a federal

grant and is an excellent example of the capacity Tulsa has to implement complex IT projects across multiple agencies. It illustrates how a third party organization might implement such a complex project, outside the government sphere, to bring together complex systems and establish mutually agreed upon standards and architecture. *The project is outlined here to illustrate Tulsa's capacity on projects of this scale.*

MyHealth Access Network is a 501(c)(3) non-profit organization offering physicians and patients the most effective, cutting-edge technology available in health care information. Patient care is improved because providers and specialists have direct access to one another to collaborate on patient care. Providers are able to instantly access patient health information through a secure connection.

The plan that emerged from the planning session enabled the organization to qualify for a $12 million U.S. HHS **Beacon Community Awards**, which funded the initial launch of the organization from 2010 to 2013. MyHealth's formation was guided significantly by the experience of the Secure Medical Records Transfer Network (SMRTNET), another Oklahoma health information exchange that had been under development since 2004 and had been live since March 2008 serving facilities in other parts of the state. Various factors lead the two organizations to remain separate, and for a time, they were in competition with one another.

Funding from U.S. Department of Health & Human Services was critical to build an innovative model that shifted health information exchange (HIE) from a mere sending/receiving of documents to sending health information data elements that support a robust patient record, business analytics reports and community health reports. It also supported a community-wide non-profit effort that has helped MyHealth become the most unique HIEs in the nation.

MyHealth has facilitated the region's participation in many national initiatives which has brought millions of dollars of additional funding to our region, creating hundreds of new jobs and raising Oklahoma into the national spotlight. We have become a demonstrate site for how effective implementation of health information technology, in a collaborative cooperative effort lead primarily by the private sector can fuel improvement in the quality of health outcomes, the health of individuals, at a lower overall cost.