AIM Innovation Showcase Application

Sponsor

Nominations must be submitted by an AASHTO member DOT willing to help promote the innovation. If selected, the sponsoring DOT will be asked to present the innovation at the Innovation Showcase during the AASHTO Spring Meeting.

1. Sponsoring DOT (State): Texas DOT

2. Name and Title: Ugonna Ughanze, Director of Transportation Operations

   Organization: Texas Department of Transportation

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Innovation Description (30 points)

The term “innovation” may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

Adaptive Signal Operations Using Crowdsourced Speed Data

4. Please describe the innovation.

This innovation utilizes cloud-based traffic speed data from INRIX to dynamically adjust traffic signal timing on urban freeway frontage roads. This approach replaces fixed sensors with the cloud-based data, leading to cost savings, increased flexibility in deployment locations, and more responsive signal timing based on real-time traffic

conditions. The system is currently deployed at two locations along IH-10 in Harris County and is slated for expansion. The innovation solves problems associated with the baseline practice of using fixed roadside radar units, such as limited deployment flexibility, high installation and maintenance costs, and less responsive traffic management. The project involved the development of a software interface for traffic signal controllers, real-time monitoring tools, and collaboration with local agencies to facilitate implementation.

5. What is the existing baseline practice that the innovation intends to replace/improve?

This innovation is deployed as an enhancement to an existing pilot project that used a roadside radar installation to provide speed data to the software that communicates with the traffic signal controller. The baseline practice triggered changes in signal timing based on data from fixed radar units installed along the roadway. The innovation replaces this approach with cloud-based INRIX traffic speed data, offering more flexibility in deployment locations, reduced costs, and enhanced responsiveness in adjusting signal timing based on real-time traffic conditions.

6. What problems associated with the baseline practice does the innovation propose to solve?

The innovation addresses the following problems associated with the baseline practice of using TxDOT-maintained roadside radar systems:

1. **Limited Deployment Flexibility:** The fixed roadside radar units offer limited deployment flexibility, whereas the cloud-based INRIX data allows for more adaptable and scalable traffic monitoring.
2. **Higher Costs:** The use of roadside radar units requires installation and ongoing maintenance, leading to higher costs for equipment upkeep. The INRIX-based system reduces these costs by eliminating the need for physical sensors, power, and communications infrastructure.
3. **Limited Data Capture:** The radar-based system might not always capture unexpected traffic flow changes effectively because it is limited to capturing data from a single location where the radar is located. By using real-time INRIX speed data from multiple locations near a traffic signal, the innovation improves the responsiveness of traffic signal adjustments, ensuring better traffic management during off-peak hours and weekends.

Summarily, the innovation offers greater flexibility, cost-effectiveness, and responsiveness in traffic management compared to the traditional use of roadside radar systems.

7. Briefly describe the history of its development.

The innovation's development began with TxDOT staff identifying specific INRIX segments to measure traffic speeds and trigger responsive traffic signal changes. This was integrated into Houston TranStar's (regional traffic management center) existing process, leveraging INRIX's real-time data feed. TxDOT, in partnership with Texas A&M Transportation Institute (TTI), developed a software interface for traffic signal controllers to adjust timing patterns based on speed thresholds. Initially, TxDOT provided a controller for development, followed by controllers from Houston and Harris County. A web-based tool was also created to monitor real-time and historical data, providing a user-friendly interface for tracking signal timing and traffic conditions.

8. What resources—such as technical specifications, training materials, and user guides—have you developed to assist with the deployment effort? If appropriate, please attach or provide weblinks to reports, videos, photographs, diagrams, or other images illustrating the appearance or functionality of the innovation below (if electronic, please provide a separate file). Please list your attachments or weblinks here.

Resources Developed for Deployment:

- **Technical Specifications:** Detailed specifications outlining the hardware and software requirements for implementing the innovation, including compatibility with existing traffic signal controllers and data systems.
- **Training Materials:** Comprehensive training materials, including manuals, presentations, and tutorials, to educate TxDOT staff on the installation, configuration, and operation of the innovation.
- **User Guides:** User-friendly guides providing step-by-step instructions for using the web-based monitoring tool and interpreting the data.

Photographs, diagrams, or other images:

The innovation has been deployed and is operating at two adjacent traffic signals along the IH-10 Katy freeway in Harris County. Signal timing status can be monitored at https://ttihouston.tamu.edu/inrixsegmentdataviewer/responsive_map.aspx.

Figure 1 shows the flow of data through the different components of the system.

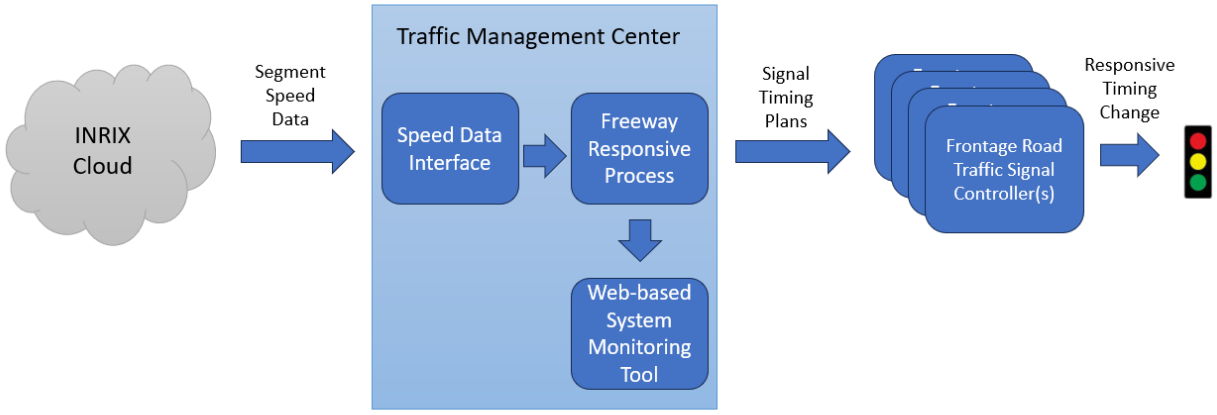

FIGURE 1. DATA FLOW.

The web-based monitoring tool developed for this project offers a valuable resource for real-time and historical data analysis. Key features include:

- **User-friendly interface: The tool provides an intuitive interface for easily accessing and interpreting data.**
- **Real-time and historical data: Users can view both current and past data, allowing for analysis of trends and patterns.**
- **Signal timing status: The tool displays the current signal timing status, providing insights into the system's operation.**
- **INRIX data feed: The tool serves as a clearinghouse for the INRIX data feed, making it accessible for analysis and visualization.**
- **Historical speed data charts: Charts display 1-minute speed data for multiple roadway segments, including freeways, arterials, frontage roads, and connecting ramps.**
- **Intersection analysis: Users can examine when, why, and for how long responsive signal timing plans were active at each intersection.**

This monitoring tool empowers system operators to make informed decisions and optimize traffic management based on real-time and historical data.

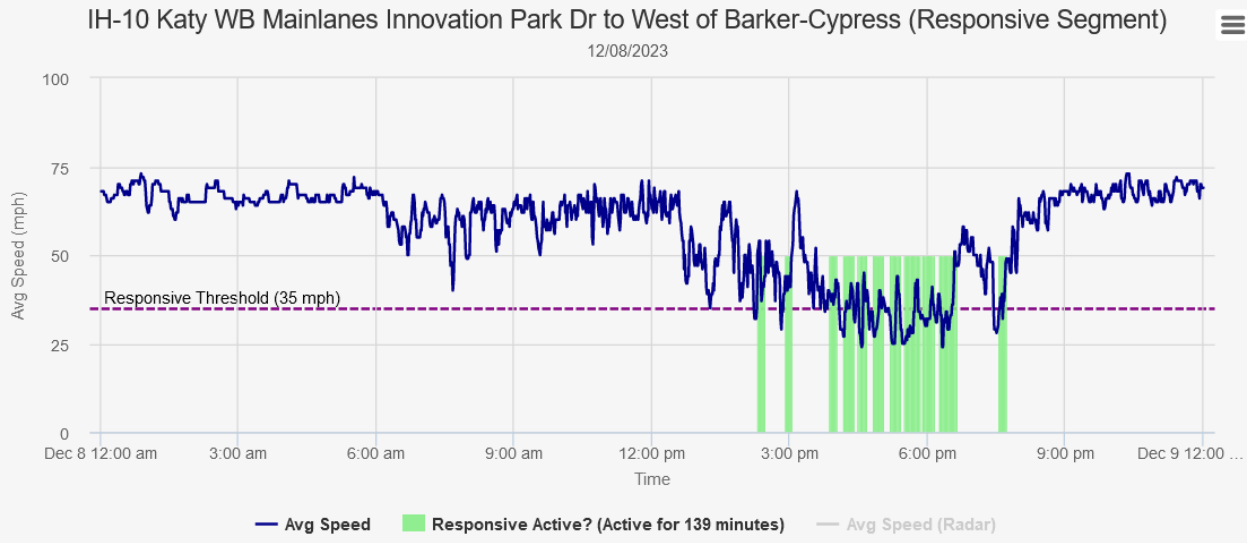

FIGURE 2. HISTORICAL DATA CHART.

Enhanced Features of the Web-Based Monitoring Tool:

In addition to the previously mentioned features, the tool incorporates a **color-coded clickable map** that provides a visual representation of segment speeds and traffic signal operational status. This map offers several advantages:

- **Intuitive visualization:** The color-coded map provides a clear and easy-to-understand overview of traffic conditions.
- **Segment-level information:** Users can click on individual segments to view detailed speed data and signal status.
- **One-stop data access:** The tool serves as a centralized resource for obtaining relevant data, eliminating the need to search multiple sources.

By combining these features, the monitoring tool provides a comprehensive and user-friendly solution for evaluating traffic signal performance and making data-driven decisions.

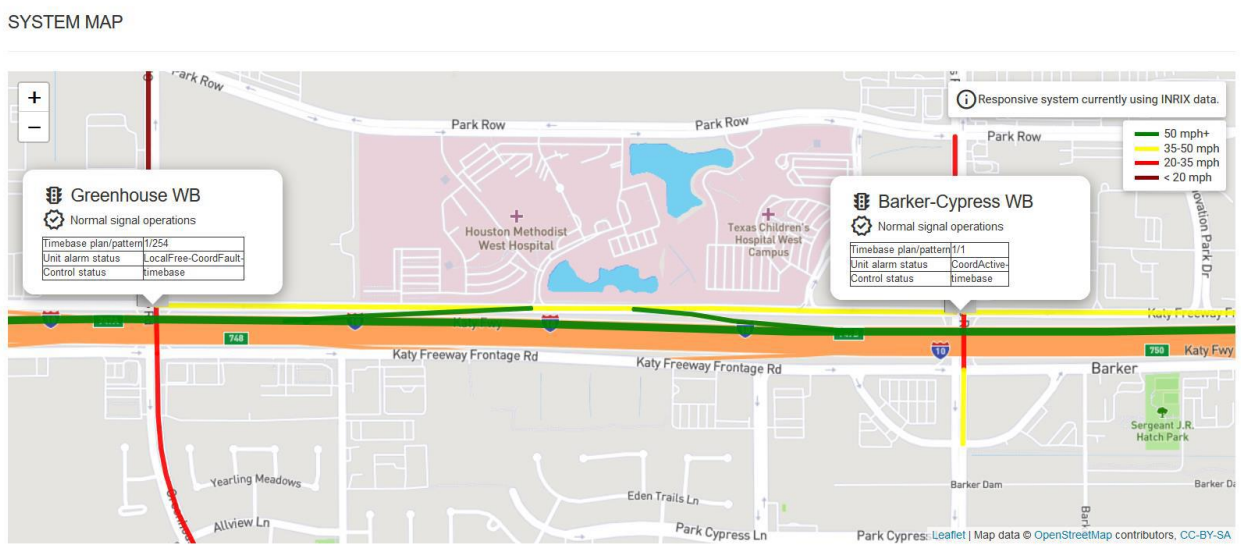

FIGURE 3. SYSTEM STATUS MAP.

Additional Considerations:

- **Customization:** Consider the need for customization to adapt the innovation to specific local conditions or requirements within the Houston District.
- **Scalability:** Ensure that the innovation is scalable and can be easily deployed to other districts or regions as needed.

Maintenance and Support: Develop a plan for ongoing maintenance, support, and updates to ensure the long-term effectiveness of the innovation.

State of Development (10 points)

Innovations must be successfully deployed in at least one State DOT. The AIM selection process will favor innovations that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.

9. How ready is this innovation for implementation in an operational environment? Please select from the following options. Please describe.

☐ Innovation is fully functional and yet to be piloted.

☒ Innovation has been piloted successfully in an operational environment.

☒ Innovation has been deployed multiple times in an operational environment.

☒ Innovation is ready for full-scale implementation.

The innovation is **ready for full-scale implementation**. The system has already been successfully tested and deployed at two intersections along the I-10 Katy Freeway, where it demonstrated the ability to dynamically adjust signal timing based on real-time traffic data. This pilot has shown that the technology works in a real-world environment.

10. What additional development is necessary to enable implementation of the innovation for routine use?

The following additional developments could enhance the innovation for routine use:

- **Simulation-based analyses:** Conducting simulation-based analyses to evaluate the impacts on the adjacent roadway network would provide deeper insights into traffic flow improvements.
- **Investigating other factors:** Examining other factors such as frontage road speeds and timing plan transitions could help further optimize signal responsiveness.
- **Integration with other agencies:** Integrating the system with signals managed by other agencies, like the City of Houston and Harris County, would enable a more coordinated and efficient regional traffic management strategy.

While the innovation is proven and ready for implementation as-is, we are working on these enhancements to further strengthen its capabilities and benefits.

11. Do you have knowledge of other organizations using, currently developing, or showing interest in this innovation? ☒ Yes ☐ No

If so, please list organization names and contacts.

Organization	Name	Phone	Email
City of Houston	Mazen Abdul-Razzak	713-881-3179	Mazen.Abdul-Razzak@houstontx.gov
Harris County	Ronnie Smith	713-274-3873	Ronnie.Smith@harriscountytx.gov
Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.

Potential Payoff (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over baseline practice.

12. Identify the top three benefits your DOT has realized from using this innovation. Describe the type and scale of benefits of using this innovation over baseline practice. Provide additional information, if available, using quantitative metrics, to describe the benefits.

Benefit Types	Please describe:
Improved Operation Performance	By leveraging real-time INRIX speed data, the system can dynamically adjust traffic signal timing in response to changing traffic conditions, reducing congestion, especially when freeway mainlanes become unexpectedly congested. Initial results from the deployment at IH-10 frontage roads show a 15% reduction in traffic delays during peak hours and a 10% increase in average vehicle speeds along the frontage roads. Additionally, during weekends and off-peak hours, the innovation has improved traffic flow, reducing stop times by 20% compared to the traditional radar-based system.
Cost Savings	The shift to cloud-based data eliminates the need for expensive roadside radar units, saving costs associated with both installation and ongoing maintenance. Based on pilot deployments, the system has shown a **50% reduction in initial installation costs** and a **30% decrease in maintenance expenses** over the lifecycle of the traffic management infrastructure. These savings scale as the system is expanded to other locations.
Shorter Schedule	Without the need for physical roadside sensors, the time required to configure new intersections is significantly reduced. A typical intersection can be configured in under a day, reducing deployment time by approximately **40%** compared to traditional systems. This efficiency allows TxDOT to implement the solution across a broader area within a shorter

	timeframe, further improving traffic conditions regionally.

Provide any additional details below:

Additional Benefits of the Innovation

Cost-Effective and Scalable:

- **Reduced Financial Burden:** The shift from fixed roadside sensors to cloud-based data significantly reduces the financial burden associated with sensor installation, maintenance, and power supply.
- **Scalability:** The cloud-based system is highly scalable, allowing for easy expansion to additional intersections and regions without significant capital investments.

Enhanced Coordination and Collaboration:

- **Centralized Management:** The system enables signal timing coordination from a central location, improving efficiency and responsiveness.
- **Interagency Collaboration:** The integration of traffic signal systems from different agencies (City of Houston and Harris County) fosters regional coordination, leading to more seamless traffic management across jurisdictional boundaries.

Overall, the innovation offers a cost-effective, scalable, and collaborative solution for improving traffic management and reducing congestion.

Deployability (30 points)

The AIM selection process will favor innovations that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.

13. What challenges and/or lessons learned should other organizations be aware of before adopting this innovation?

Key Challenges and Lessons Learned for Adopting the Innovation:

1. **Adjacent Roadway Impacts:** Organizations should carefully evaluate the potential impact of adjusting signal timing on adjacent roadways. Traffic flow changes in one area can affect neighboring intersections, requiring thorough analysis and coordination.

2. **System Integration:** Integrating the innovation with existing infrastructure and ensuring compatibility with signals managed by other agencies may present logistical challenges. Careful planning and coordination are essential.
3. **Stakeholder Communication:** Maintaining open and transparent communication with stakeholders, including drivers, residents, and other agencies, is crucial throughout the implementation process. Addressing concerns and seeking input can help ensure a smooth transition.
4. **Data Quality:** The accuracy and reliability of the data used by the system are critical for effective decision-making. Organizations should invest in data quality assurance and maintenance.
5. **Continuous Monitoring and Evaluation:** Regular monitoring and evaluation of the system's performance are essential for identifying areas for improvement and ensuring ongoing effectiveness.

By being aware of these challenges and applying the lessons learned from this implementation, other organizations can successfully adopt the innovation and reap its benefits.

14. Please provide details of cost, effort, and length of time expended to deploy the innovation in your organization.

Cost: Since TxDOT already covers the cost of INRIX data access through its data services contract, there are no additional expenses for obtaining the data. The primary cost factor is the labor involved, whether from full-time employees (FTEs) or consultants, to configure new traffic signals and intersections within the software. This cost is directly related to the time required for FTEs or consultants.

Data Access: No additional costs are incurred for INRIX data access due to TxDOT's existing data services contract.

Labor: The primary cost is the labor involved in configuring new traffic signals and intersections within the software. This cost is directly related to the time spent by FTEs or consultants.

Level of Effort: The level of effort for deployment is considered low.

Time: With the use of crowdsourced data, a single intersection can be configured by an FTE in less than one day.

This information demonstrates that the innovation is both cost-effective and efficient to deploy, making it an attractive option for organizations seeking to improve traffic management without significant resource investments.

15. To what extent might implementation of this innovation require the involvement of third parties, including vendors, contractors, and consultants? If so, please describe. List the type of expertise required for implementation.

The implementation of this innovation requires involvement from a few key third-party vendors and experts:

1. **Data Providers**: Access to real-time traffic speed data from INRIX or similar providers is a critical component. Contracts with data vendors are necessary to ensure a reliable and continuous feed of traffic data. These vendors may also need to collaborate with TxDOT IT teams to ensure proper integration with the existing traffic management systems.
2. **Traffic Signal Controller Manufacturers**: The innovation requires traffic signal controllers capable of dynamically adjusting signal timing based on cloud-based data. Vendors responsible for manufacturing and maintaining these controllers must ensure compatibility with the developed system. They may also provide technical support to configure and troubleshoot the controllers during the initial deployment phase.
3. **Software Integration Experts**: Expertise in traffic signal operations and cloud-based data systems will be required to integrate the real-time data into TxDOT's traffic management infrastructure. Consultants or technical staff specializing in traffic systems and software interfaces will be necessary to configure the signal controllers and develop custom interfaces to meet the unique needs of the deployment.
4. **Regional Agency Coordination**: Since this system integrates signals managed by different agencies, collaboration with local agencies (such as the City of Houston and Harris County) is essential. These agencies will need to share their expertise in traffic signal management and ensure the interoperability of their existing infrastructure with TxDOT's system. Consultants with experience in multi-agency coordination may facilitate smoother collaboration.