

Unveiling Crash-Prone Hotspots Through Telematics Data: A Near-Crash Analysis

Regional Safety Advisory Committee Meeting

October 24th, 2025

Presented by Jason Wu (TTI)

TxDOT 0-7200 Project Overview

TxDOT 0-7200: Leveraging Telematics Data for Enhanced Traffic Safety: Unveiling Crash-Prone Hotspots and Mitigating Incidents

Traffic safety is a paramount concern, and leveraging telematics data provides a unique opportunity to enhance our understanding of potential crash incidents and hotspots. This project aims to employ advanced telematics analysis techniques, focusing on identifying crash-prone hotspots and developing effective strategies to mitigate incidents. The multifaceted approach encompasses data exploration, algorithm development, and spatial analysis, all aimed at creating a robust framework for improving overall traffic safety.



TxDOT 0-7200 Project Overview

Project Objectives – Phase I

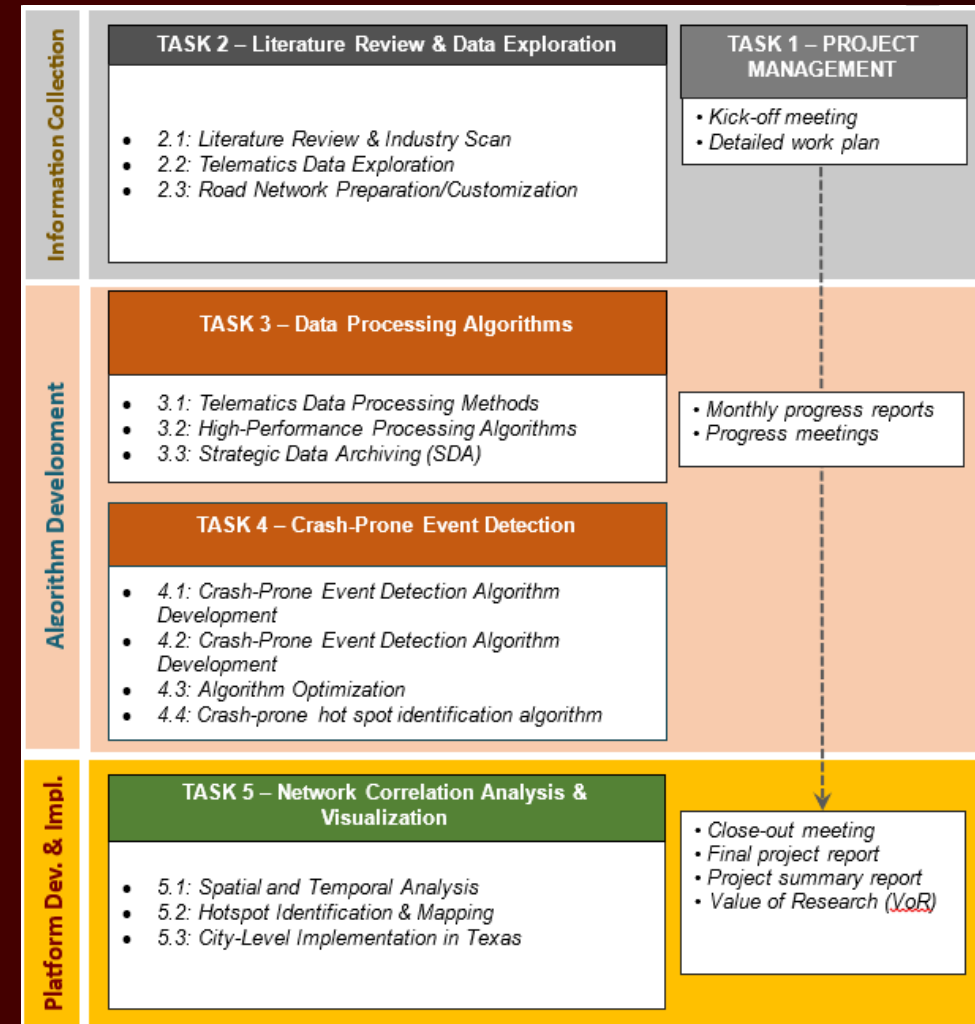
- 1) Telematics Data Exploration and Assessment
- 2) Advanced Data Processing Algorithm Development
- 3) Strategic Data Archiving (SDA) Methodology
- 4) Crash-Prone Event Detection
- 5) Hotspot Analysis and Network Visualization

Phase I
(TRL -6)

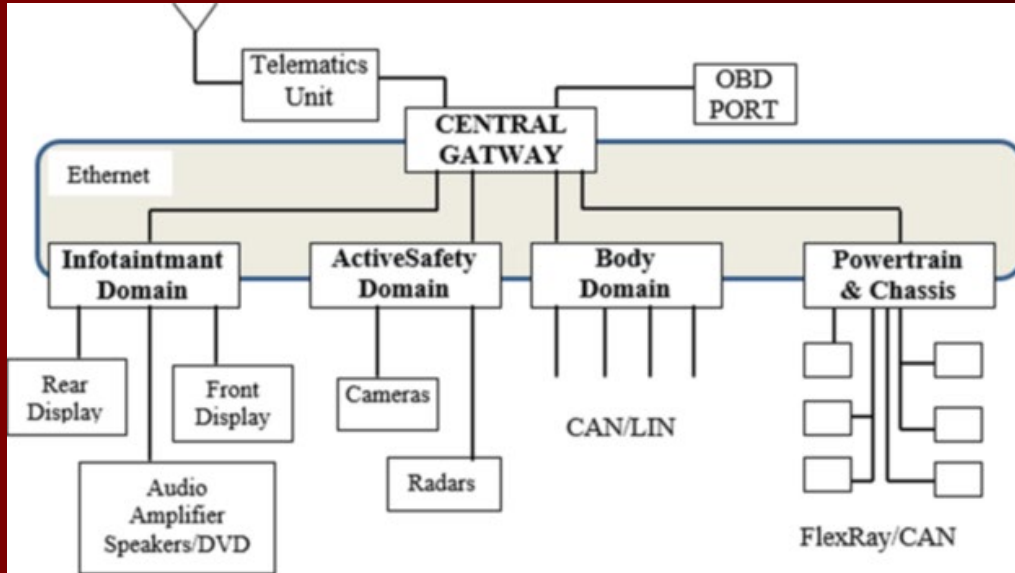


Phase II
(TRL -8)

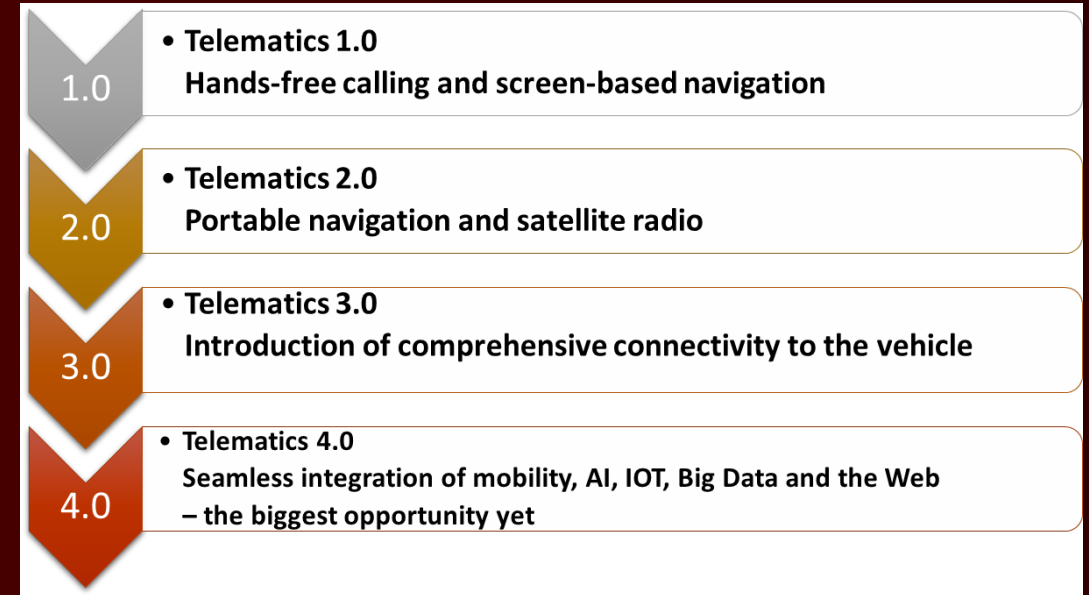
Phase I



Telematics Data/Connected Vehicle Data

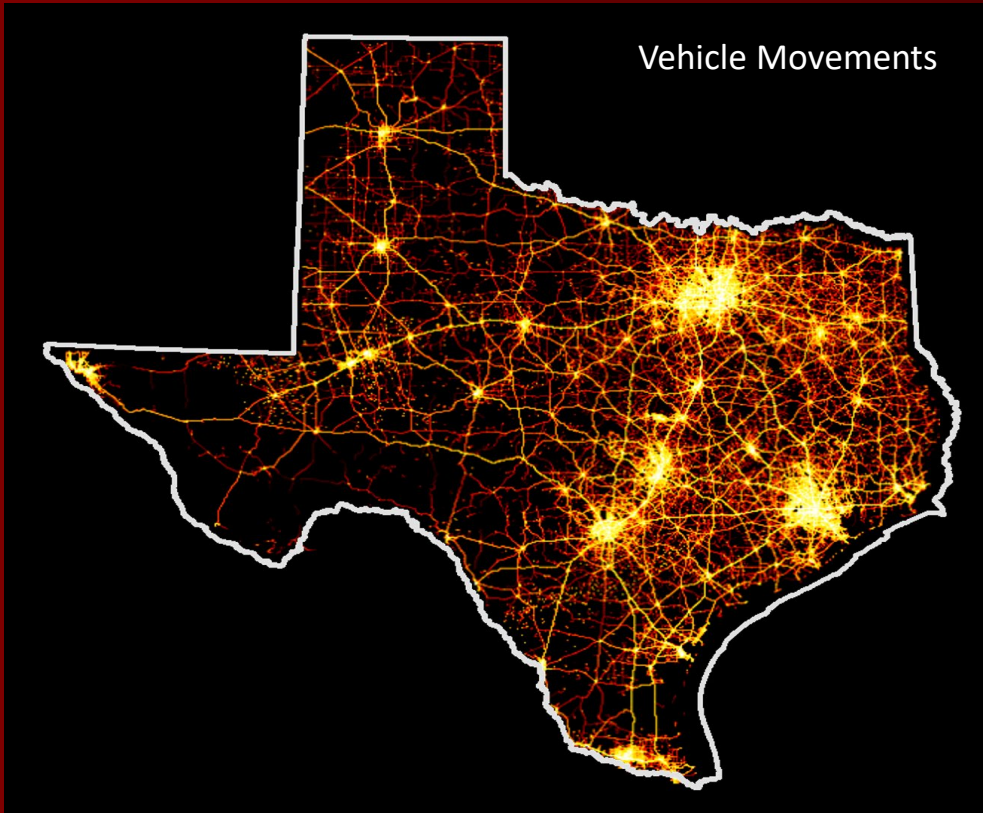


A Vehicle with Telematics Sensor and Systems



The Evolution of Telematics Technology

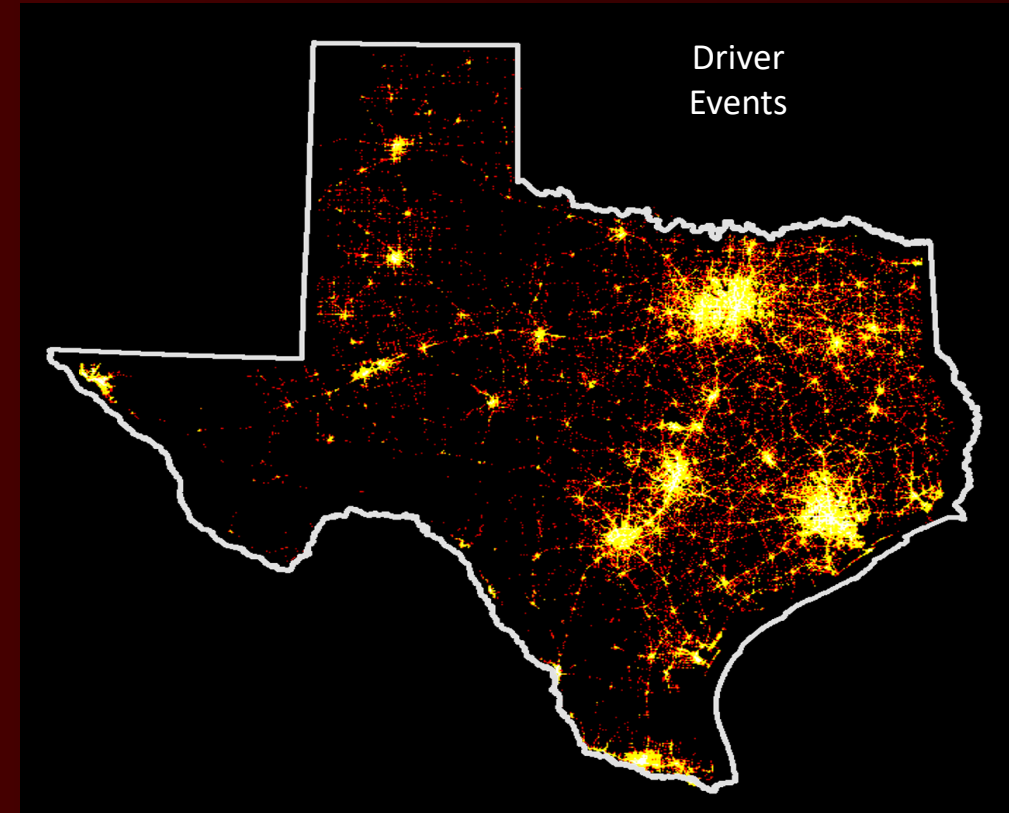
Telematics Data/Connected Vehicle Data



Statewide coverage
Nov. 2021 – May 2023
Wejo/Streetlight CVD

Vehicle movements

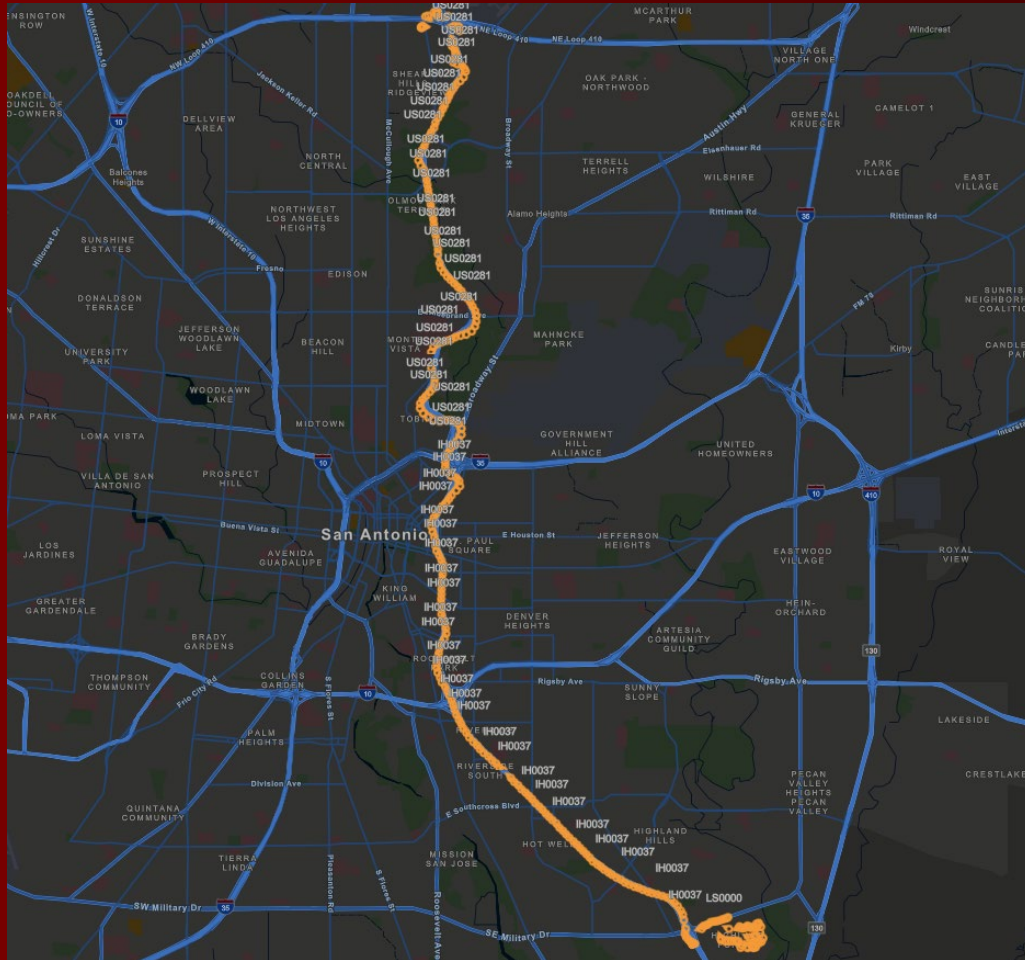
1.2 trillion points
Every 3-seconds (mostly): location, speed, heading, etc.



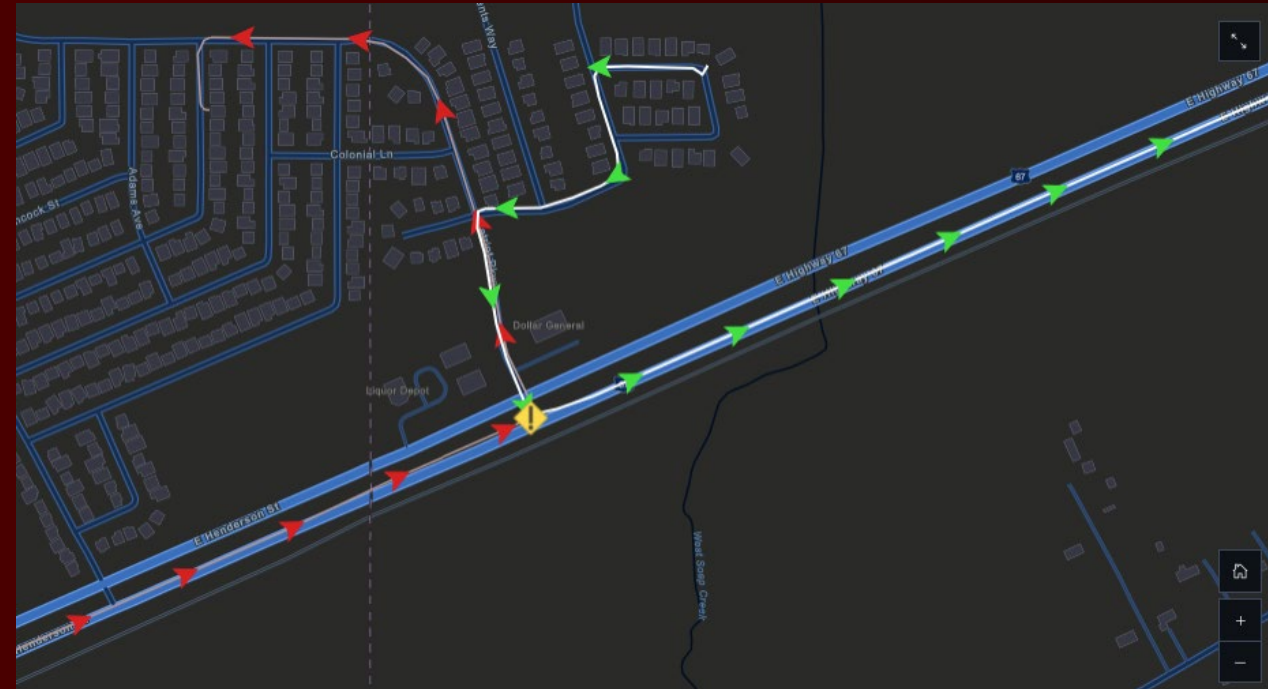
Driver events

27 billion points
When an event occurs: hard braking, seatbelt latch, etc.

Telematics Data/Connected Vehicle Data

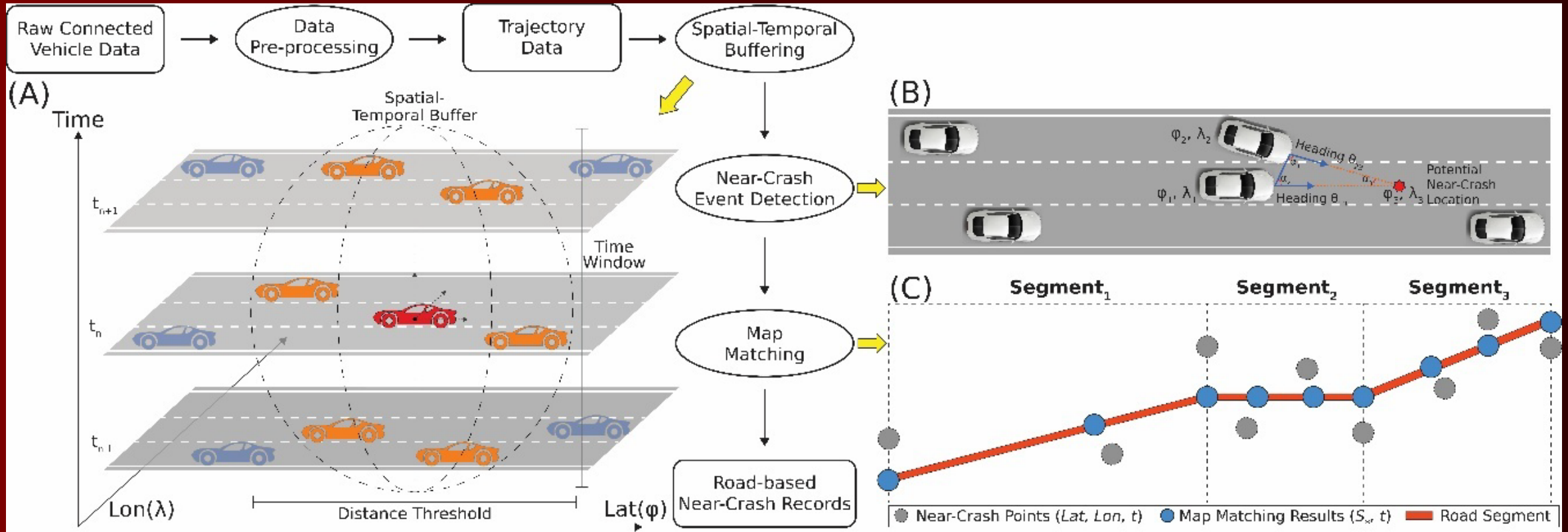


A Sample CVD Trajectory (Wejo)



A Sample Near-Crash Event
From CVD (US 67 @ Patriot Pkwy)

The Framework for Near-Crash Analysis Through Telematics Data



$$d_{13} = \arctan\left(\frac{\sin d_{12} * \sin \alpha_1 * \sin \alpha_2}{\cos \alpha_2 * \cos \alpha_1 * \cos \alpha_3}\right)$$

$$\varphi_3 = \arcsin(\cos \varphi_1 * \cos d_{13} + \cos \varphi_1 * \sin d_{13} * \cos \theta_{13})$$

$$\Delta\lambda = \arctan\left(\frac{\sin \theta_{13} * \sin d_{13} * \cos \varphi_1}{\cos d_{13} - \sin \varphi_1 * \sin \varphi_3}\right)$$

$$\lambda_3 = (\lambda_1 - \Delta\lambda + \pi) \% (2\pi) - \pi$$

Time to Collision (TTC)

$$t_{13} = \frac{d_{13}}{v_1}, t_{23} = \frac{d_{23}}{v_2}$$

$$TTC = \min(t_{13}, t_{23}), \text{ if } t_{13} - 1.5s \leq t_{23} \leq t_{13} + 1.5s$$

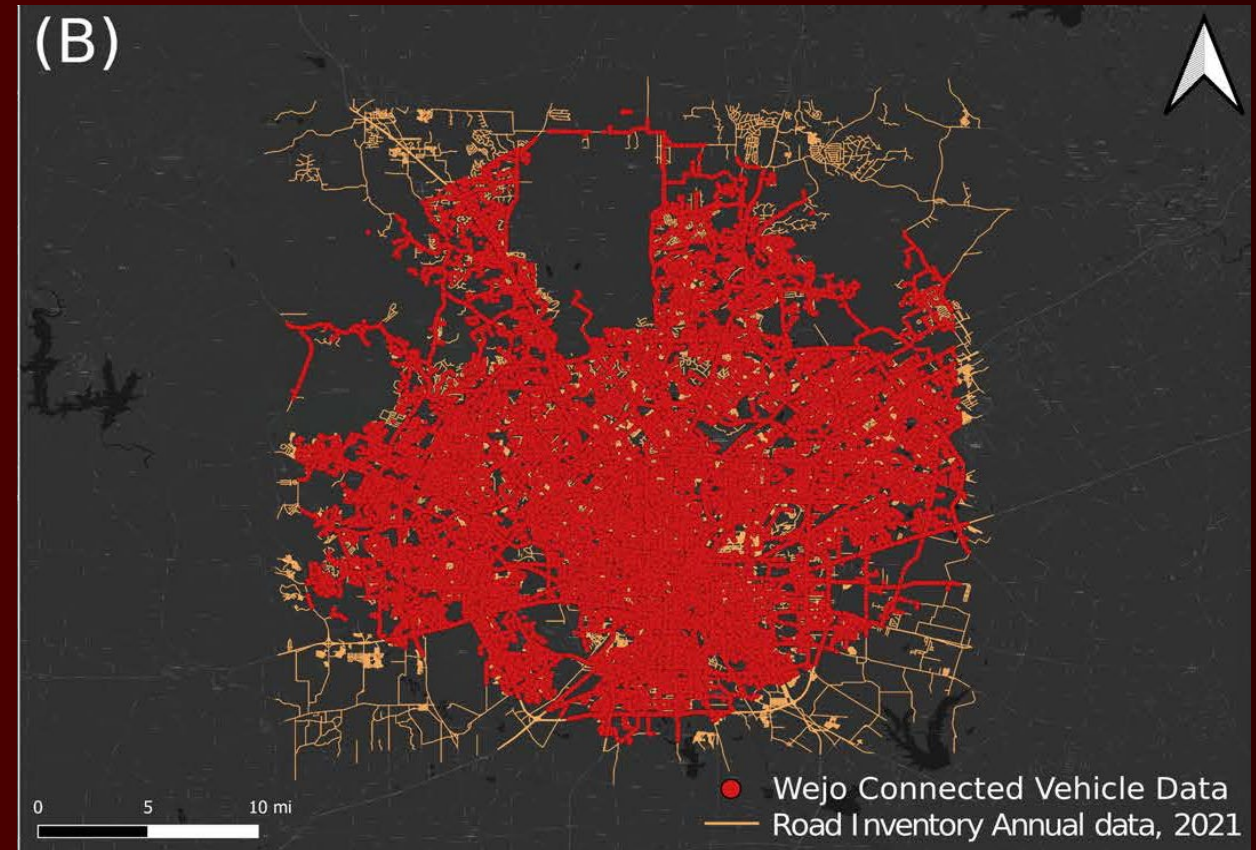
The San Antonio Study

The Wejo CV Data (Movements):

- The one-month Wejo data from 11/01/2021 to 11/30/2021 are used in this study.
- The raw dataset documents over 2.9 billion data points from 7.9 million unique trajectories.

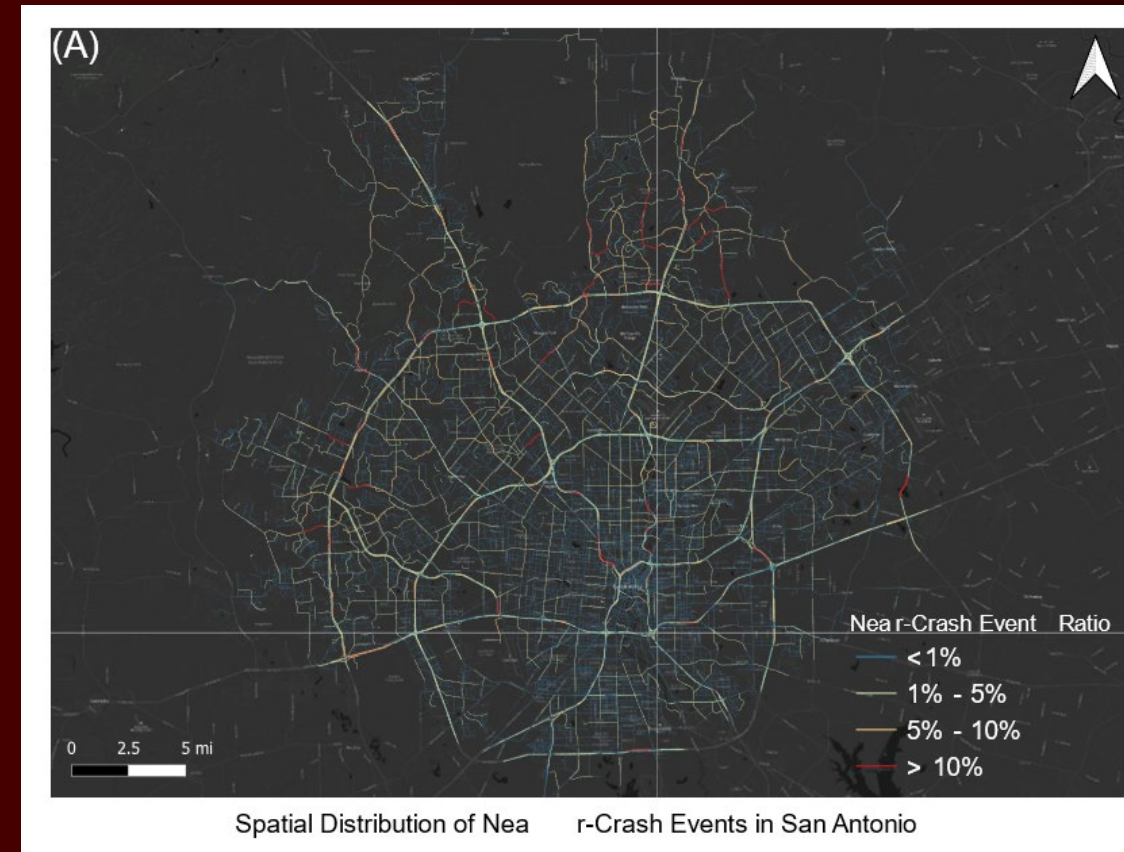
Table 1 Example Records of Wejo Connected Vehicle Data in 11/01/2021

Data Point ID	Journey ID	Timestamp (t)	Lat(ϕ)	Lon(λ)	Speed	Heading (θ)	Ignition Status
105623589	94a69188fc92e9bde	08:10:18	29.*****	-98.*****	0	238	KEY ON
236598742	4f9cba35e35ac567d	15:21:39	29.*****	-98.*****	25	254	MID JOURNEY
...	...	...	...	...	...	...	...
453219856	94a69188fc92e9bde	08:15:59	29.*****	-98.*****	45	32	MID JOURNEY
105623511	785e1b0b6c68d3069	07:10:21	29.*****	-98.*****	50	185	MID JOURNEY
598746523	4f9cba35e35ac567d	15:25:29	29.*****	-98.*****	60	25	MID JOURNEY
263598421	785e1b0b6c68d3069	07:15:35	29.*****	-98.*****	0	228	KEY OFF



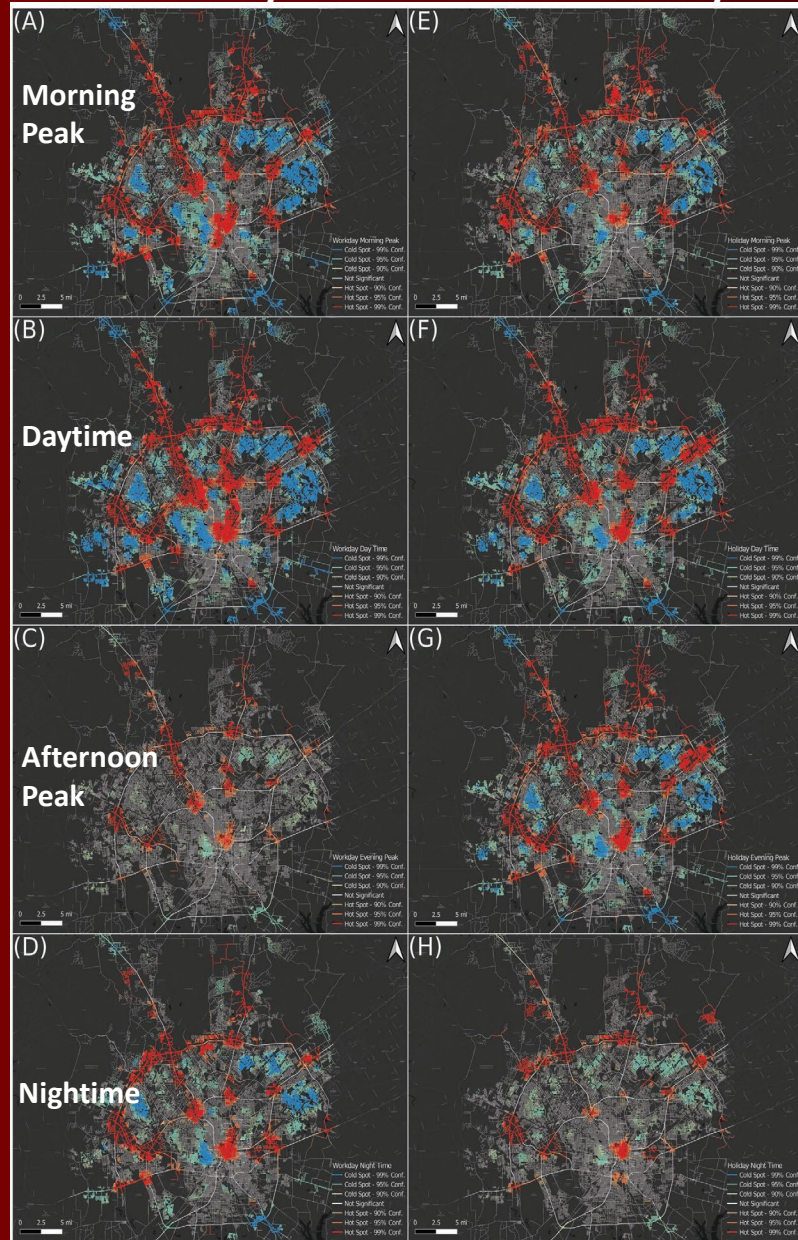
The San Antonio Study

- The analysis identified 3.38 million near-crash events across 42 roads and 13,231 road segments in November 2021.
- Figure (in the right) displays the spatial distribution of near-crash risks across road segments.
 - High-risk road segments (76 segments) where near-crash event ratios exceed 10% (Dark Red)
 - Low-risk segments (9,975) where the ratio is below 1% (Blue)



Workdays

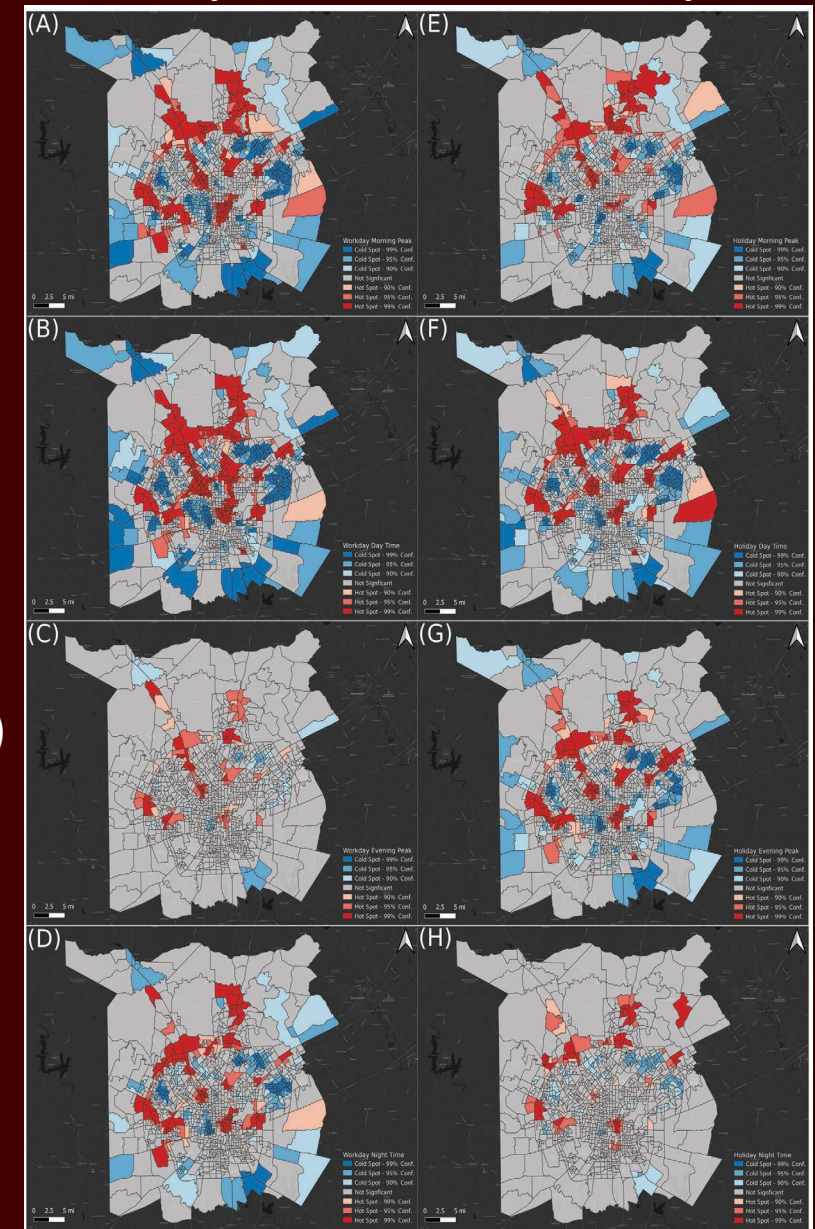
Non-workdays



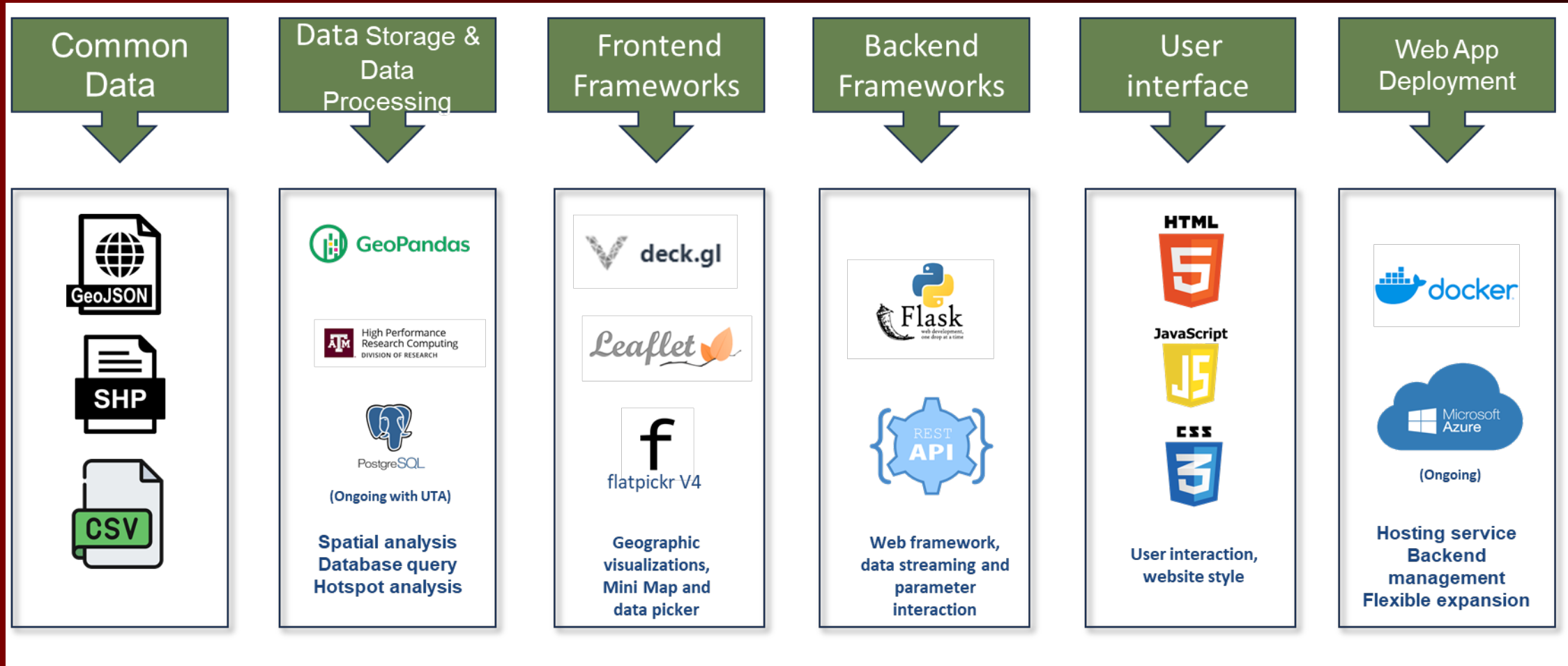
Hotspot Identification and Visualization (Nov. 2021, San Antonio, TX)

Workdays

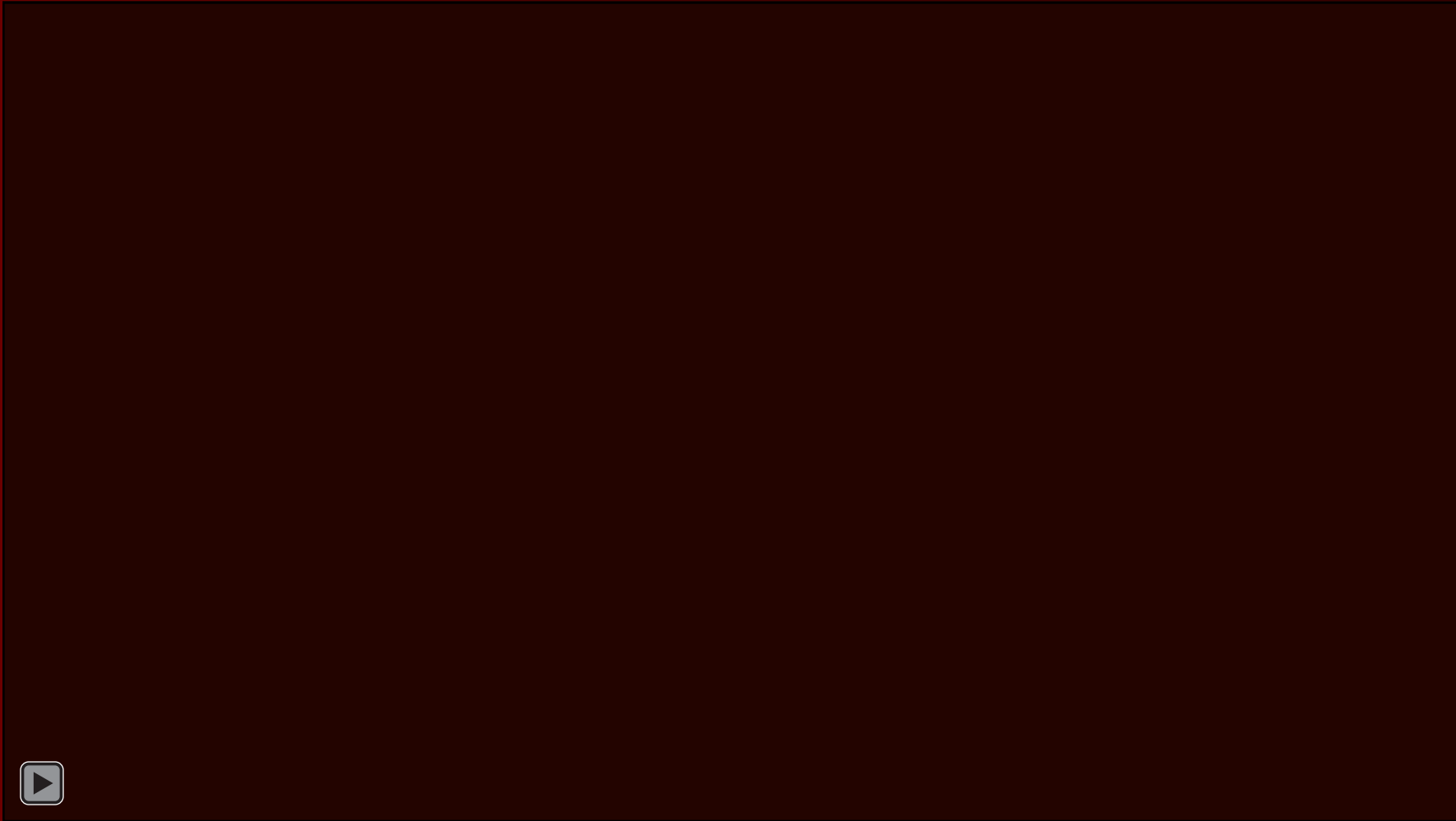
Non-workdays



The Web Application



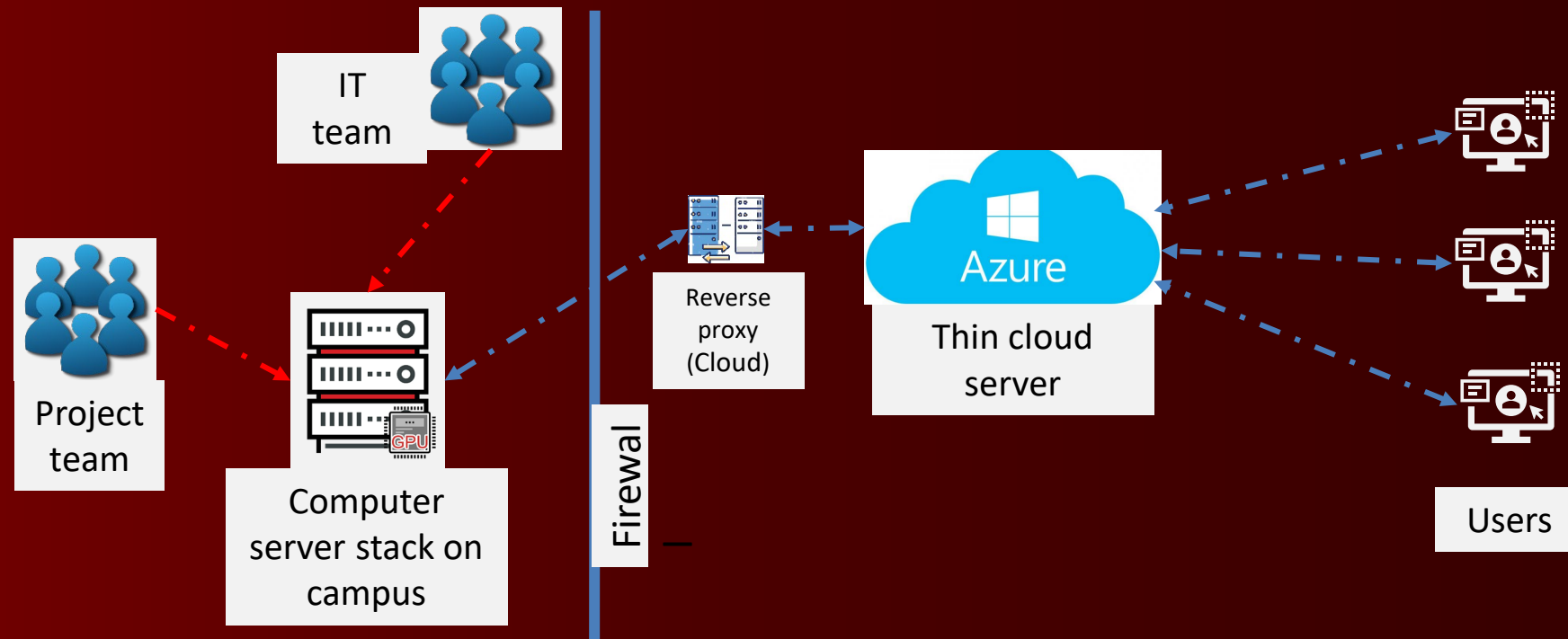
The Web Application



Phase II Extension:

Full-Stack System Development:

- Employ high-performance computing techniques to process and state-wide telematic data
- Data fabrication for target performance measures



Questions?



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