

LiDAR-powered, safety-centric Traffic Signal Systems

-TxDOT LiDAR Pilot Deployment in San Marcos

For the TexITE Fall conference,
Sep 2025, El Paso

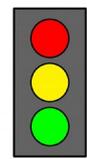
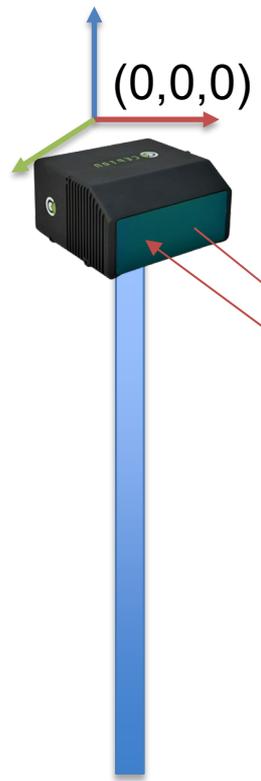
Taylor Li, P.E., Ph.D., Associate Professor, UTA
Ning Zou, Ph.D., P.E., Transportation Manager, San Marcos, Texas



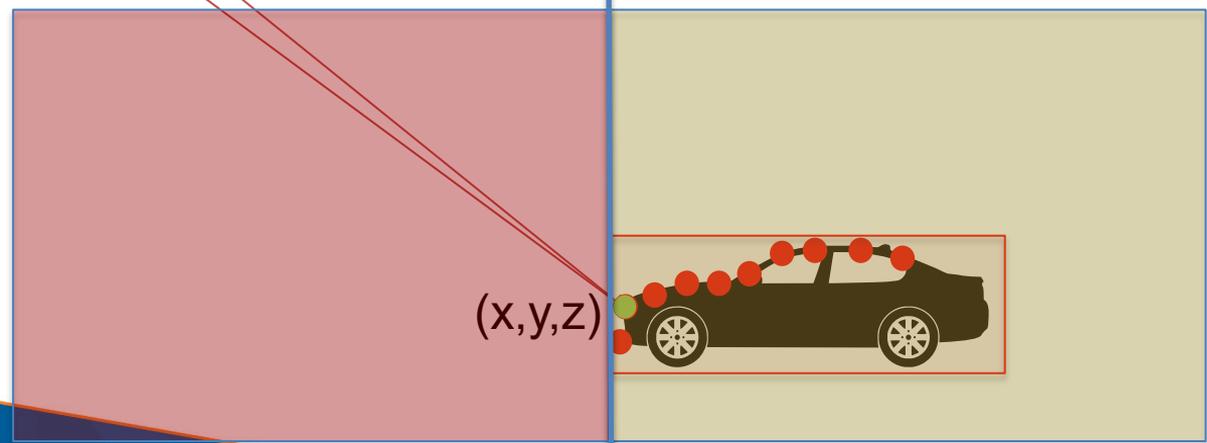
Outline

- **TxDOT LiDAR pilot deployment in San Marcos**
- **Preliminary feedbacks**
- **Next Steps**

How do LiDAR sensors work?



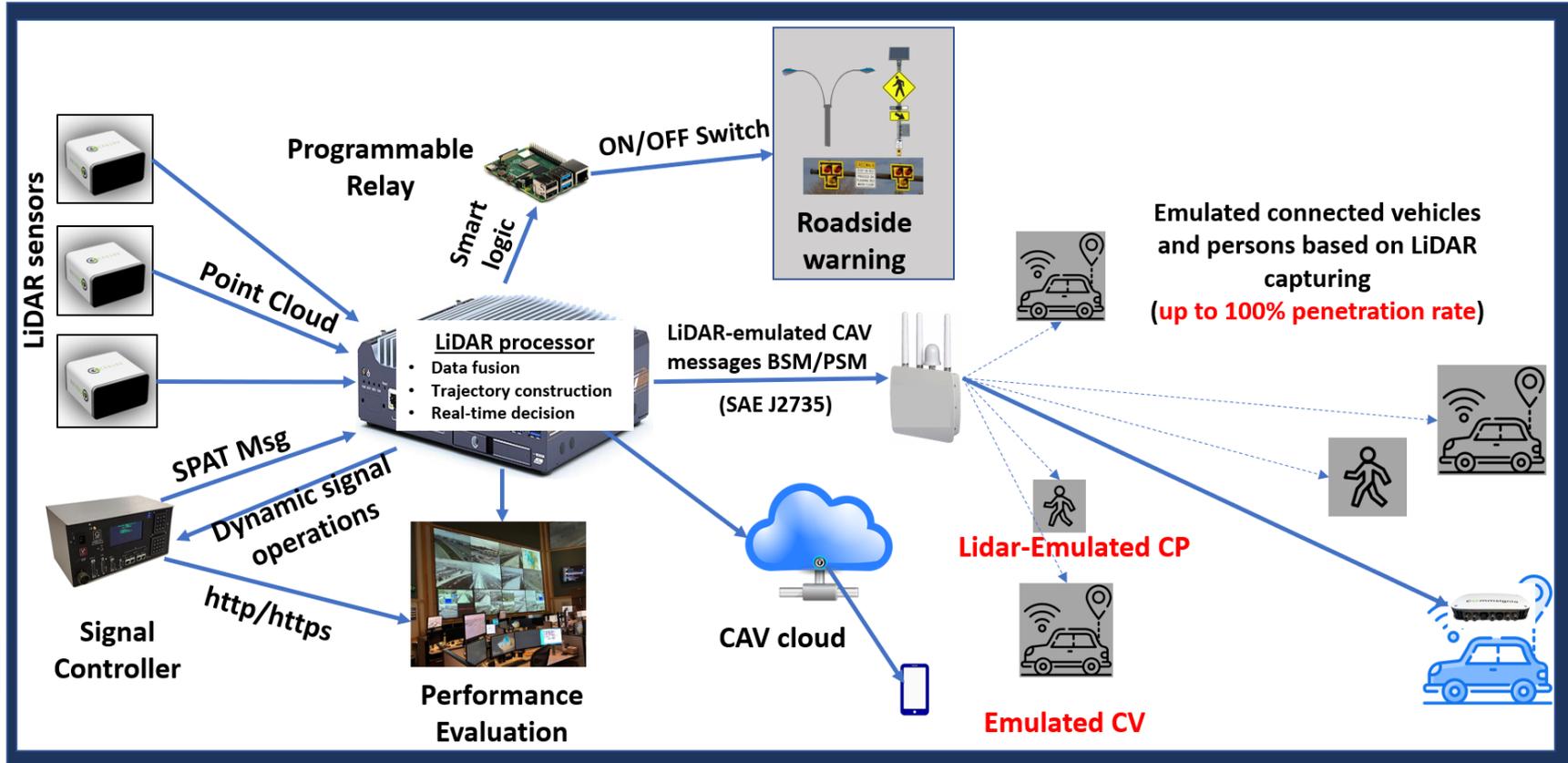
STOP LINE



USDOT Intersection Safety Challenge

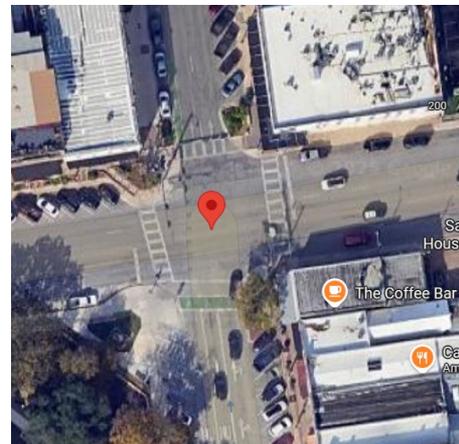
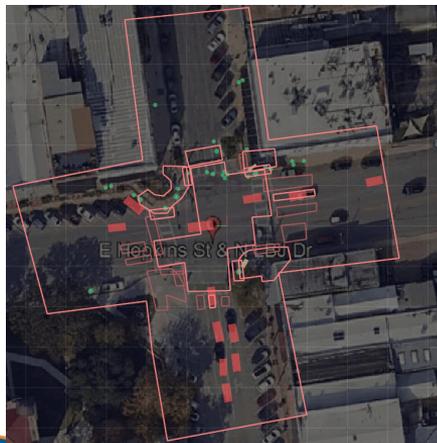
- **The USDOT Intersection Safety Challenge is a federal initiative to reduce crashes and improve safety at intersections**
- **UTA supported TxDOT to submit a concept paper based on our previous research experience on LiDAR**
 - **It was selected for Stage 1A prize**
- **TxDOT flowed this prize to UTA to catalyze a LiDAR pilot project, supported by City of San Marcos**

System architecture in a nutshell



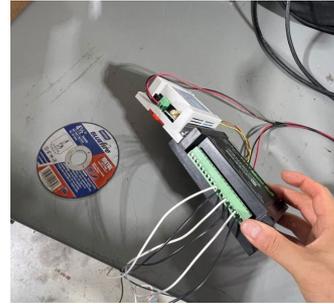
Location information

- E Hopkins St. & N LBJ Dr., San Marcos, TX
- Two-phase fixed timing and one-way street (NB)
- A high volume of unsober (drunk) crossing pedestrians after mid nights and frequent red-light running
 - Low-speed, high-crash
- Frequent Parallel parking



System Fabrication

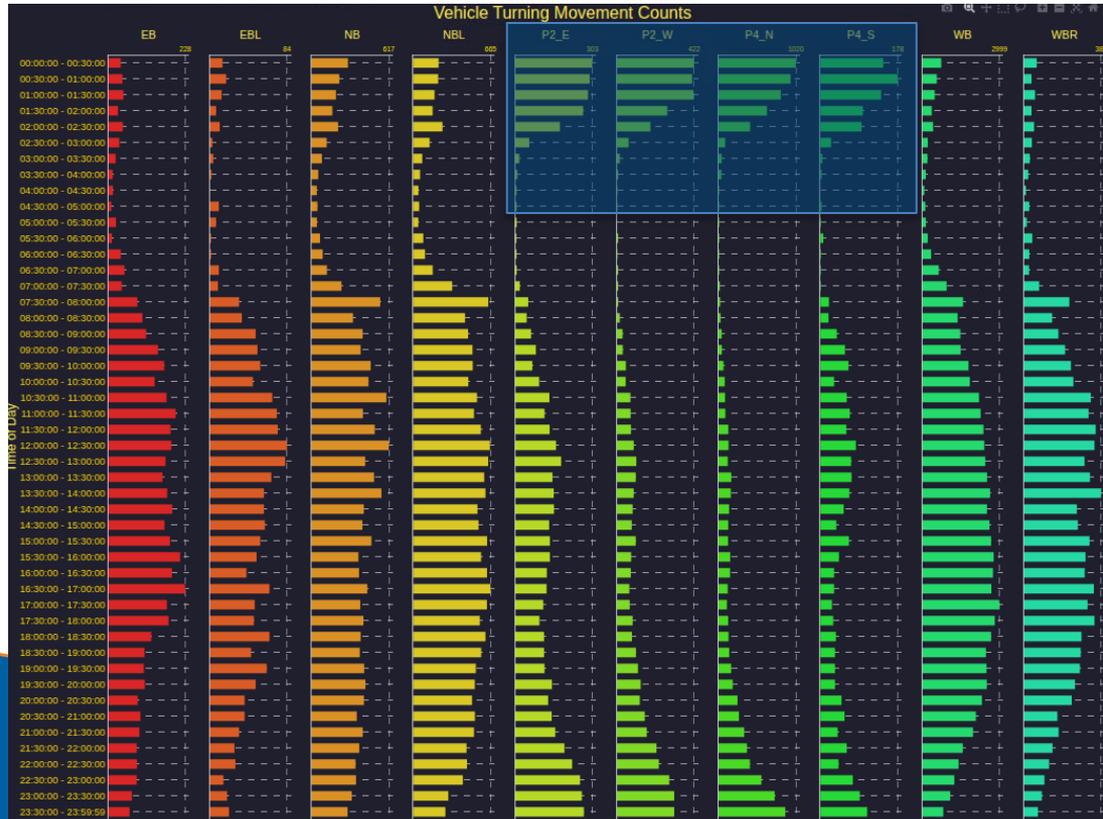
- The LiDAR sensors and LiDAR perception software are off the shelf, but they arrived as parts.
- We first assembled them and then integrated with UTA integration algorithms
 - Overall, it is easy for technicians and distributors
- On site, it took about 2 hours to install 2 sensors and put the system online if wires were pulled in advance.
 - Take another hour to draw and couple zones for the target problems back in office



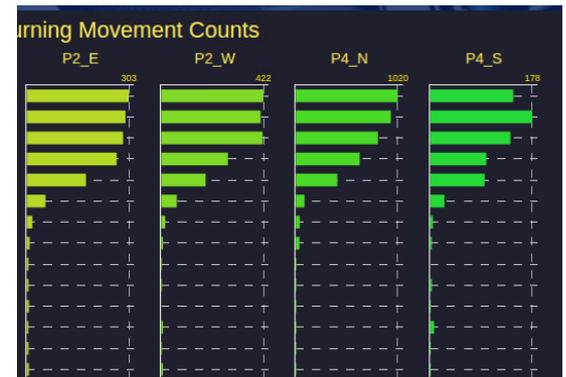
Planned tactics to protect pedestrians

- Behavioral Data collection and visualization for engineering judgement (off-line)
- Increasing traffic signal's responsiveness to unexpected behaviors (online)
- Adding various road-side warning systems to remind approaching vehicles of crossing pedestrians
- Integrate with emerging CV2X infrastructure with TxDOT support

Turning counts analytics (From Sep 10~Sep 17, 2025)



- Ped volumes increase rapidly after 10 PM and reached the highest from 23:30 PM to 1 AM.
 - Max volume: **4,000** peds at mid-night
- Ped activities stopped after 2:30 AM
- No AM/PM peaks (typical college town in the summer)
- Few vehicles at mid night, meaning they are fast



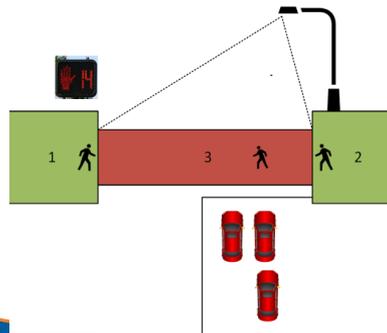
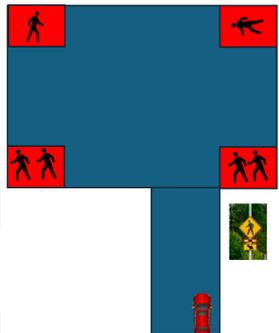
Pedestrian behaviors and safety



- People walk slow!
 - 15% slower than 3.5 ft/s
- Perception reaction time is long
 - Waiting area is small
 - Distracted

Dynamic roadside warning and lighting systems

- **Supplemental lighting for crossing pedestrians**
 - Beam light activation is associated with WALK compared to mid-block lighting
 - When WALK is ON, and a waiting pedestrian begins to enter, it is turned on.
 - Dynamically extend pedestrian clearance up to 6 sec
- **Ped ahead warning:**
 - If there are too many pedestrians, turn on the warning sign upstream to approaching vehicles



Integration with CV2X infrastructure

- CV2X is a national prioritized technology for traffic safety
- Using LiDAR to emulate surrounding vehicles and pedestrians to warn connected vehicles
 - LiDAR+CV2X can help alert drivers the nearby travelers.
- Multiple ongoing research projects in Texas is supporting this effort.

Applied Info RSU, Commsignia RSU, Yunex RSU are all on the table



Early evaluations

- The system works as expected with 99+% accuracy
 - Remotely evaluated with the city's PTZ camera and its YouTube channel
- Highly effective in protecting vulnerable road users



Local feedback

- The system was quickly appreciated by the residents and late business. They called the city and asked for more locations
 - *“I wanted to reach out and ask if the new crosswalk lights at Hopkins and N LBJ were installed by Public Works? If so, I wanted to share kudos with you for installing those. I’ve seen them in action, and we’ve also received compliments from late night businesses. We love the new lights! Are there plans to install more?”*
 - *“Dr. Li, I would love to be kept in the loop as you develop this prototype. Our Main Street Advisory Board and downtown business owners have already been asking when the city will install more of these. We have many other crosswalks that could benefit as well, and I look forward to learning more about this project.”*

III: Next Steps and Suggestions



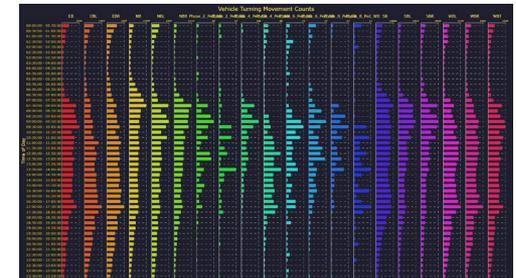
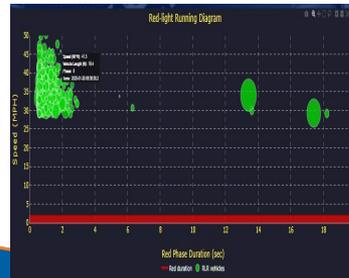
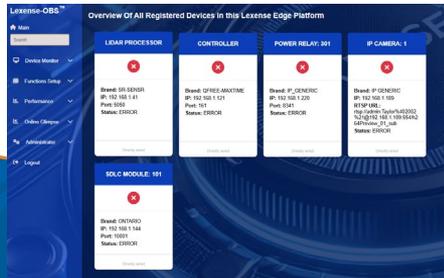
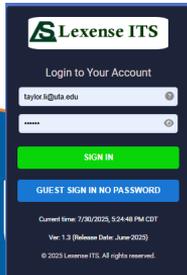
LS

Suggestions for interested agencies

- **Stop bar vehicle detection (SDLC/NTCIP):**
 - Critical but least concerning. We have extensively tested this core function with various LiDAR sensors and software. All fully meet the NEMA requirements.
- **Thinking “Out-Of-Cabinet”:**
 - Starting from the quick but highly visible safety solutions out of cabinet to the public (e.g., ped lighting), then moving into the cabinet (e.g., RLR prevention)
- **“Don’t judge a book by its cover and don’t judge a sensor by its user interface”**
 - UI should be simple, effective and should only output core data. The LiDAR system in the field is just a smart sensor to serve your bigger system.
 - Letting field devices perform central tasks is concerning.
 - Massive data operations can flash the cabinets (e.g., stop bar detection).
- **You will not spend much time on each sensor after large-scale deployment (30+)**

Last but not least...

- Good research outcomes should be handed over to agencies eventually
 - Many agencies can only accept turn-key solutions with reasonable warrant. R&D software is not a good fit.
- A turn-key, full-stack platform for agency users has been developed and is ready to deliver. It will also be the platform to carry over our new research outcome in the future.
- A safety-centric central system will be developed based on ATSPM 5 platform for new performance visualization
- This effort toward licensing is officially approved and backed by UTA.



Thank you!

Acknowledgement:

TxDOT Project advisory committee (TRF):

- Dr. Jianming Ma
- Mr. Arturo, Perez
- Mr. Tomas Lindheimer
- Mr. Joaquin Artigas

City of San Marcos (Public Works):

- Mr. Sabas Avila

Contact: Taylor Li; Taylor.Li@uta.edu