
VTRC
Virginia Transportation
Research Council


VDOT

VDOT Smart Intersection Deployment Pilot

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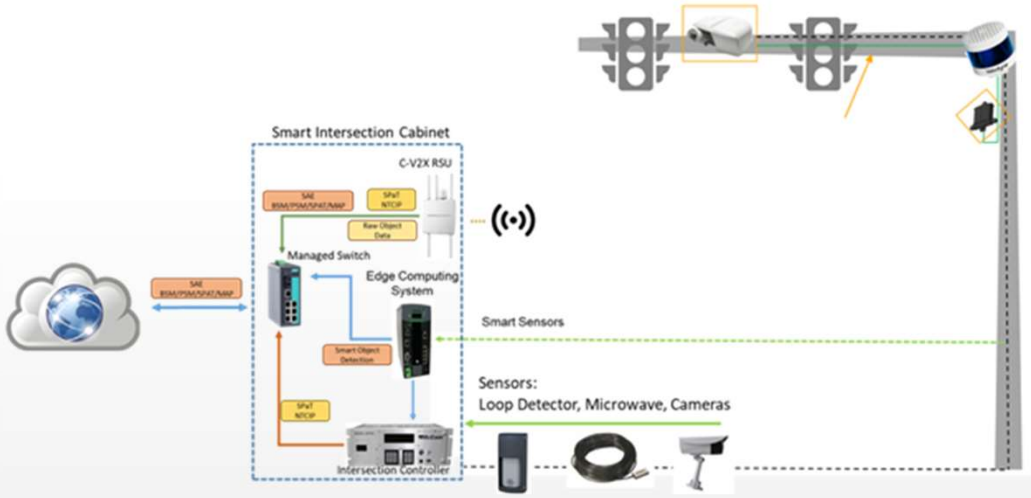
Intersection Safety in Virginia

- Crashes and serious injuries frequently occur near intersections
  - About 27% of all fatalities and 36% of serious injuries between 2016-2020 occurred at an intersection
  - Vulnerable road users are at even higher risk at intersections:
    - About 34% of pedestrian fatalities
    - About 58% of bicyclist fatalities

What is a Smart Intersection?

- **Recent advances have produced lidar, machine vision, and radar detection systems that can identify safety concerns in real time.**
- **Potential to:**
  - **Identify safety concerns (near misses) before crashes happen**
  - **Interact with signal controller to improve safety and operations**
  - **Enable future connected vehicle applications**



Smart Intersection Pilot

- **The Innovation and Technology Transportation Fund (ITTF) was established by the General Assembly to fund pilot projects for high technology infrastructure improvements. Projects funded under this program must:**
  - Reduce congestion
  - Improve mobility
  - Improve safety
  - Provide up-to-date travel data
  - Improve emergency response
- **In 2022, ITTF allocated $1 million to perform a pilot of smart intersection technology to improve safety and mobility**

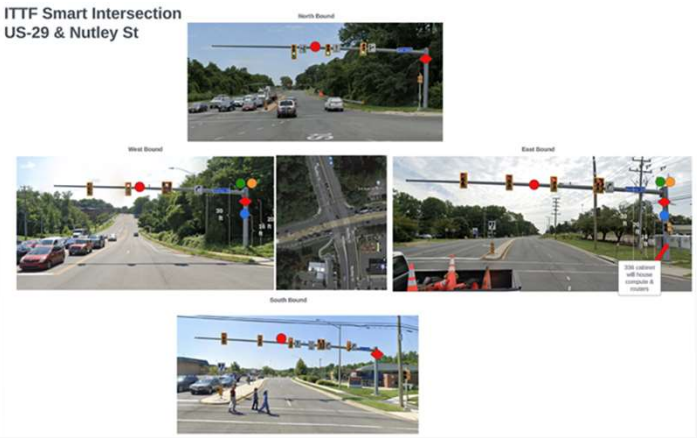
VDOT Smart Intersection Pilot

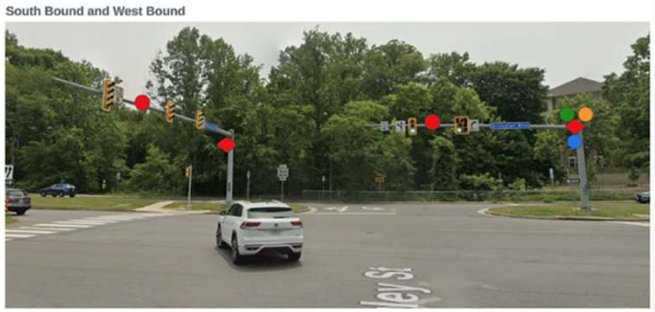
- **Phase 1: Technology testing (1/23-9/24, $482k)**
  - Assessed performance of 4 technologies to identify most promising systems
  - Systems tested in parallel at 2 intersections in Fairfax County
- **Phase 2: Expansion to more intersections (12/24-5/26, $500k)**
  - Expand testing to broader cross section of locations using most promising systems
  - 4 in VDOT Salem District
  - 4 in VDOT Culpeper District
- **Virginia Tech Transportation Institute (VTTI) is the contractor for the project (PIs: Mike Mollenhauer, Reg Viray)**

Phase 1: Technology Testing

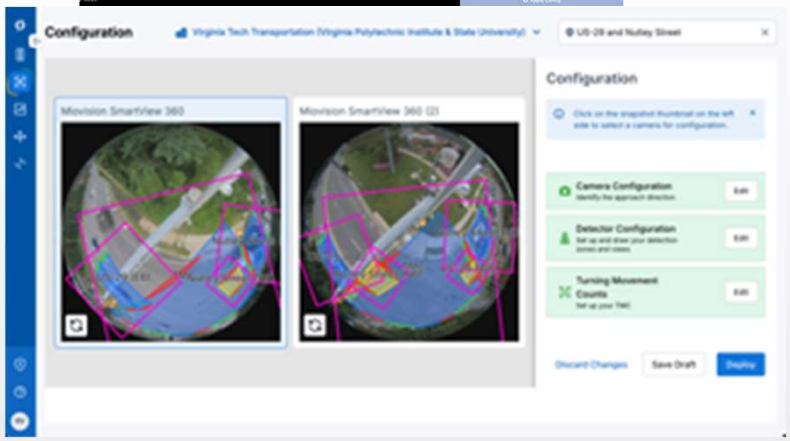
- **Testing at US 29/Nutley and US 50/Nutley in Fairfax County**
- **Technologies tested:**
  - Lidar ($36k/intersection)
  - Machine Vision ($18k/intersection)
  - Machine Vision+ Radar ($36k/int)
- **Phase 1 measures of effectiveness:**
  - Accuracy of vehicle and bike/ped counts
  - Accuracy of safety critical event detection
- **Ground truth video data collection by VTTI**

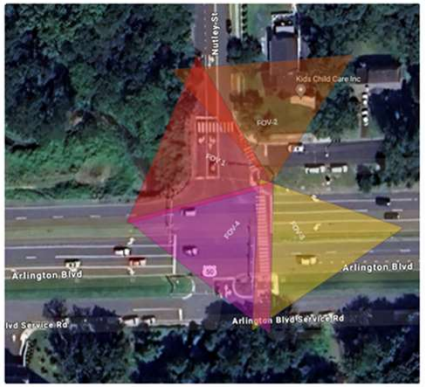
Phase 1 System Installation





System Configuration and Validation Data Collection





Safety Event: Crash Detection

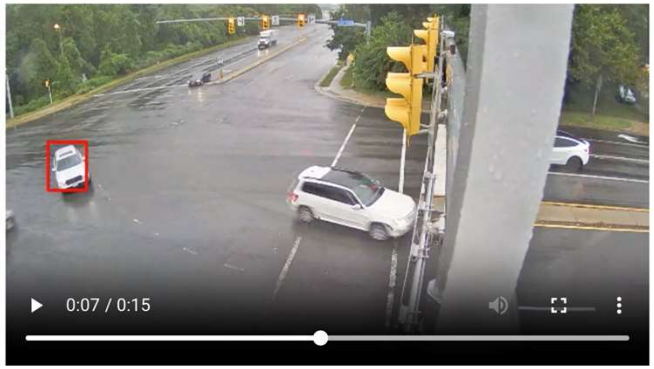
Crash BETA

Event ID : 650ecbbd8e1d300011e8eb93

Location
US-29 & Nutley Street

Detected on
September 23, 2023 07:27 AM

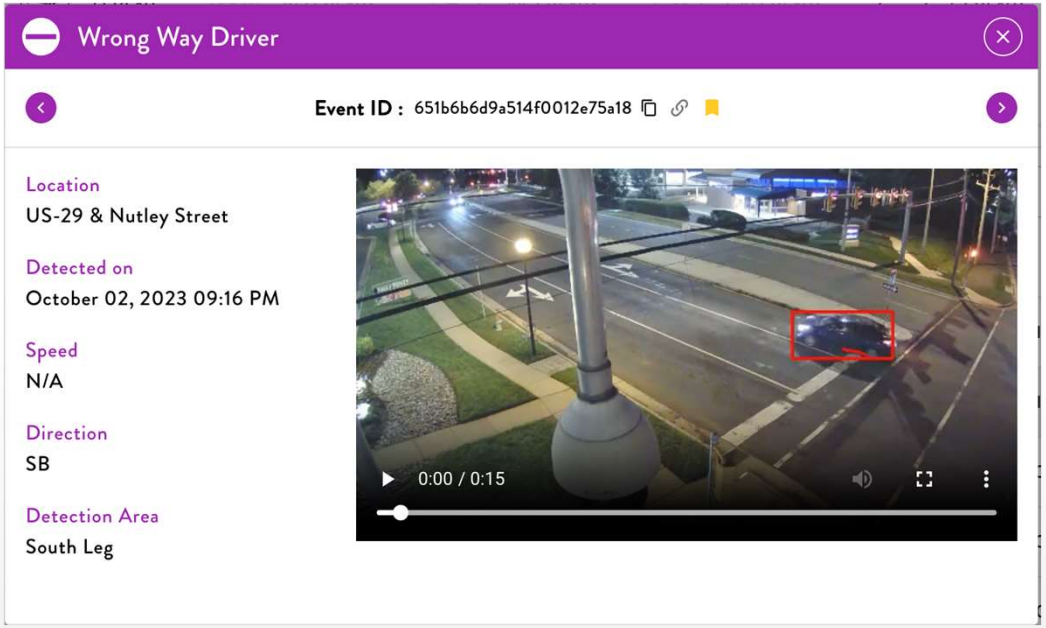
Detection Area
Intersection Center

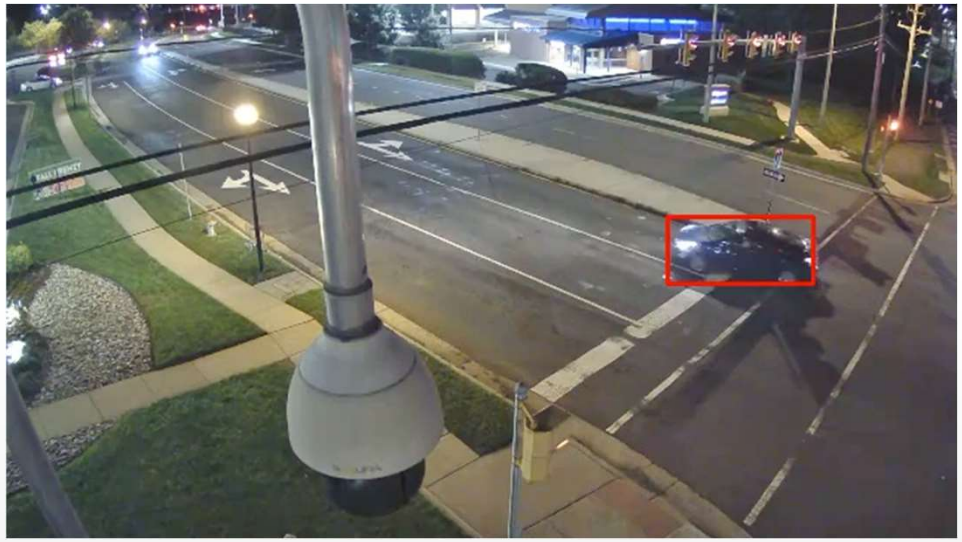


Road User A
Class: Passenger Vehicle
Speed: 13 mph
Movement: TH
Direction: NB

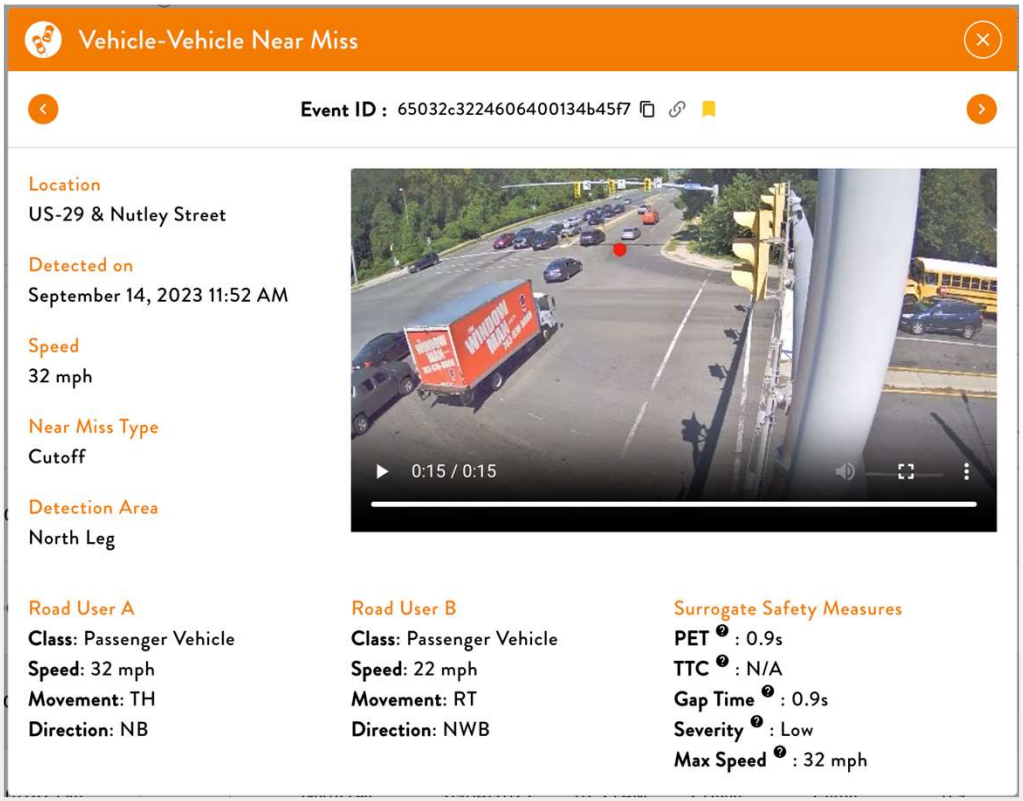
Road User B
Class: Passenger Vehicle
Speed: 14 mph
Movement: TH
Direction: SEB

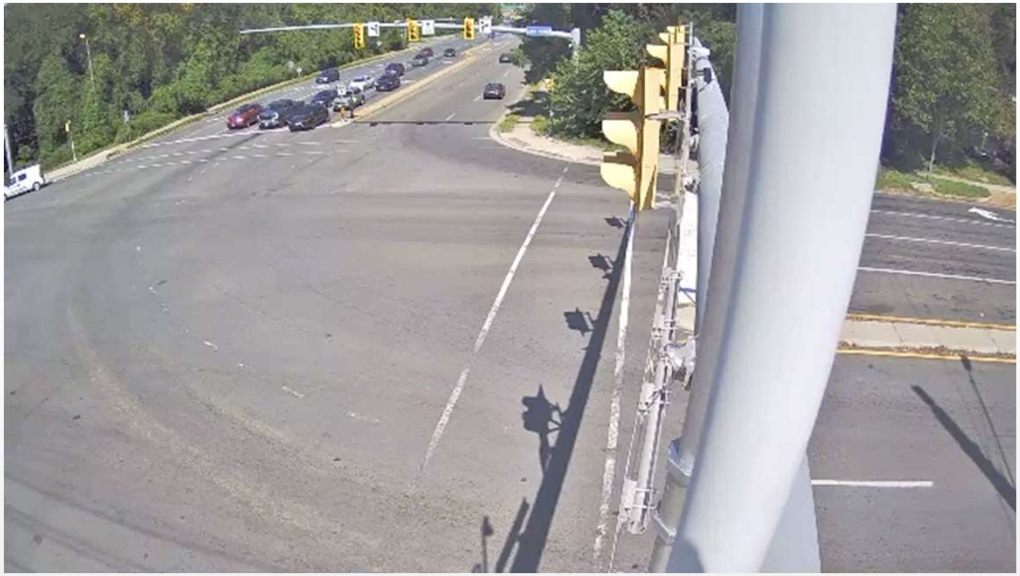
Wrong Way Driver





Vehicle-Vehicle Near Miss Detection





Vehicle-Pedestrian Near Miss Detection

Vehicle-VRU Near Miss

Event ID : 652efeeb1f92070012a764c0

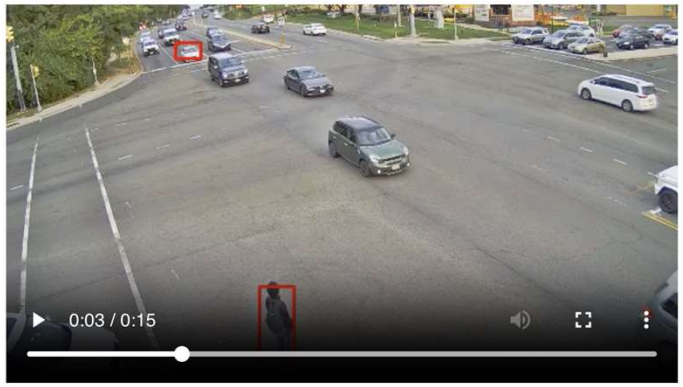
Location
US-29 & Nutley Street

Detected on
October 17, 2023 05:38 PM

Speed
25 mph

Near Miss Type
Cutoff

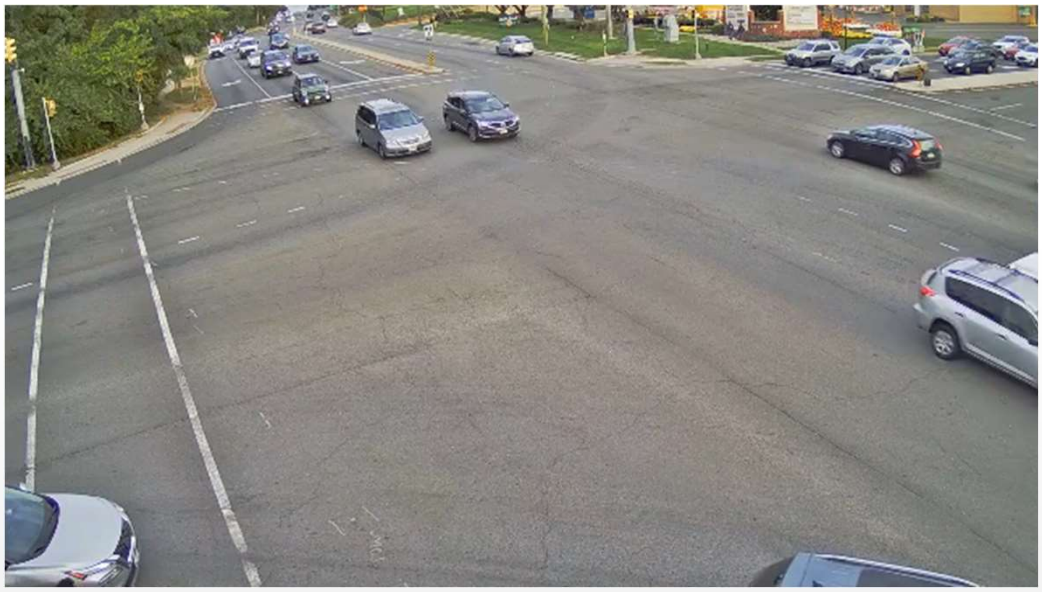
Detection Area
Intersection Center



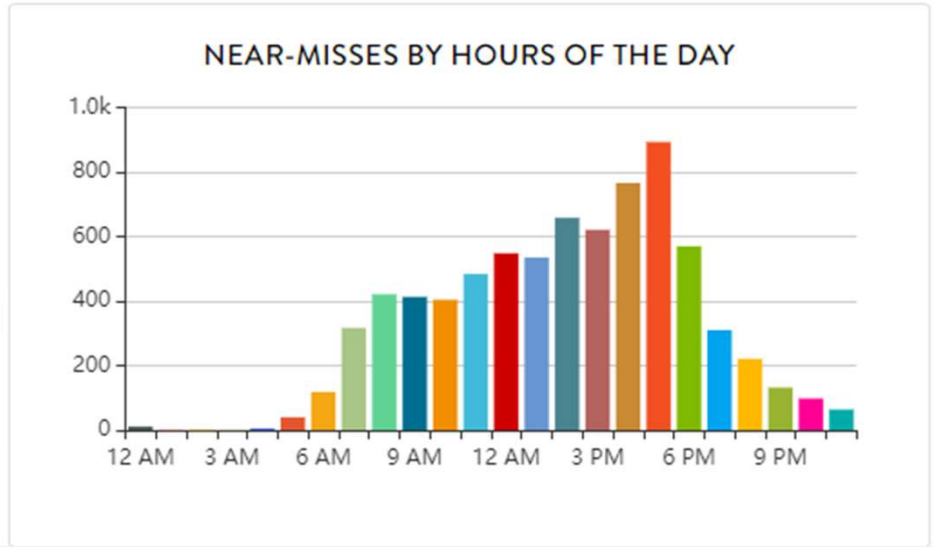
Road User A
Class: Pedestrian
Speed: 3 mph
Movement: TH
Direction: SEB

Road User B
Class: Passenger Vehicle
Speed: 25 mph
Movement: TH
Direction: WB

Surrogate Safety Measures
PET : N/A
TTC : 2s
Gap Time : 0.4s
Severity : Low
Max Speed : 30 mph



Intersection Risk Heatmap



Vendor Count Performance

- **Compared against about 2 weeks of manually counted data**
  - Mix of weather and light conditions
- **Trends**
  - Lidar system significantly undercounted traffic, especially during rain
  - Video B system had more reliability issues, but tracked counts well
  - Video C system overcounted, but results were more consistent for vehicles
  - Bike/ped counts had larger errors for video systems, but small sample sizes

Measure	Location	Lidar A	Video B	Video C
Vehicle Counts	US 29/Nutley	-28.6%	-0.9%	+8.8%
	US 50/Nutley	-47.9%	-3.8%	+4.4%
Bike/Ped	US 29/Nutley (N=89)	-44.9%	-10.1%	-8.1%
	US 50/Nutley (N=44)	-36.4%	-8.8%	+44.1%

Safety Analytics Assessment

- **Two systems produced automated safety analyses**
- **Human verification of a subset of flagged events:**
  - Lidar system results showed significant discrepancies
  - Video based system showed good performance - but engineering judgement still needed to interpret the results appropriately.

Event Type	Intersection	Detection Accuracy		Subjective Relevance		Total Assessed Events
		Counts	%	Counts	%	
Near Miss - VRU	US 29/Nutley	70	100%	16	23%	70
	US 50/Nutley	9	90%	5	50%	10
Near Miss - Vehicle	US 29/Nutley	16	100%	6	38%	16
	US 50/Nutley	13	100%	4	31%	13
Stopped Vehicle	US 29/Nutley	19	100%	19	100%	19
Wrong Way	US 29/Nutley	16	53%	16	53%	30

Phase 2: Testing Expansion

- **Installation on broader cross section of sites:**
  - 4 in Montgomery County
    - Lee/Cloverdale, Ogden/Starkey, Beamer/Southgate, US 460B/Professional Park
  - 4 in Albemarle County
  - Albemarle sites will use video based system that performed well in phase 1

Alderman/McCormick

Hydraulic/Lambs

Ivy/Old Ivy

US 29/Rio Overpass

Phase 2 Assessment

- **VTTI installing independent video verification system**
- **Culpeper District deployments will assess system performance in terms of:**
  - Detection accuracy
  - Safety critical event accuracy
  - Ability to interact with traffic signal controller
    - Signal actuation performance
    - Red light running reports
    - Red light extension functionality
    - Crosswalk conflict extensions
  - Cybersecurity

Phase 2 Anticipated Schedule

- **Procurement/installation through June 2025**
- **Evaluation and Assessment: July 2025 – January 2026**
- **System transition/handover: By May 2026**

Questions?

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