Smart Work Zone Safety Initiatives

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Partnering for Work Zone Safety

- VTTI and VDOT have been working together to improve work zone safety for over 15 years
- Initial motivations in connected and automated vehicle support
- Practical safety solutions are needed
- Easy to use tools are needed to create accurate work zone data to distribute to 3rd parties
- New commercial products are often siloed and typically not part of an integrated system



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SMART WORK ZONE

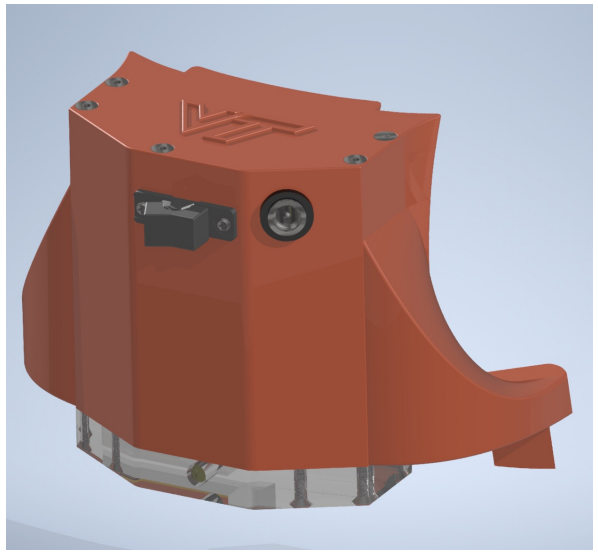
INTEGRATED COMPONENTS

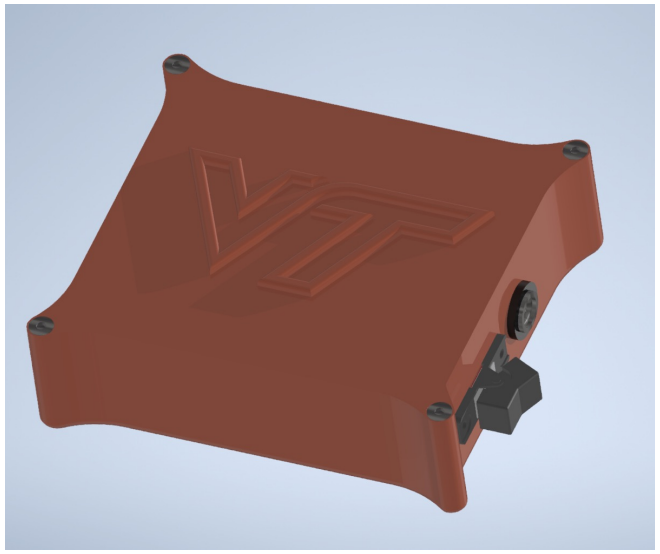
- Smart Work Zone Field System
  - Smart Vest
  - Smart Helmet
  - Equipment Unit
  - Base Station and Traffic Evaluation System
- Work Zone Builder Application
- Automated Truck Mounted Attenuator (ATMA)

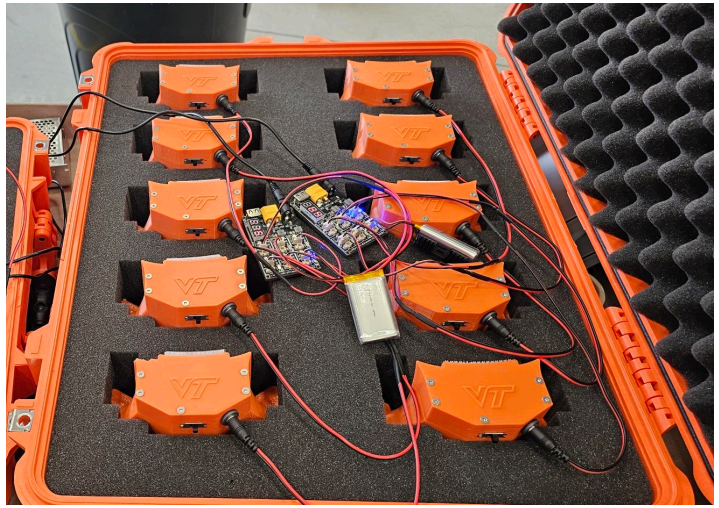


Smart Helmet / Vest

- Wearable system that integrates with Kask helmet accessory mounts
- Does not interfere with other accessories
- Wireless mesh network integrates to base station
- GPS+RTK module
- Redundant modes of warning
  - Vibrating motors
  - Chirping buzzer
  - LED halo illumination over visor
- 6 oz, 20 hours battery life











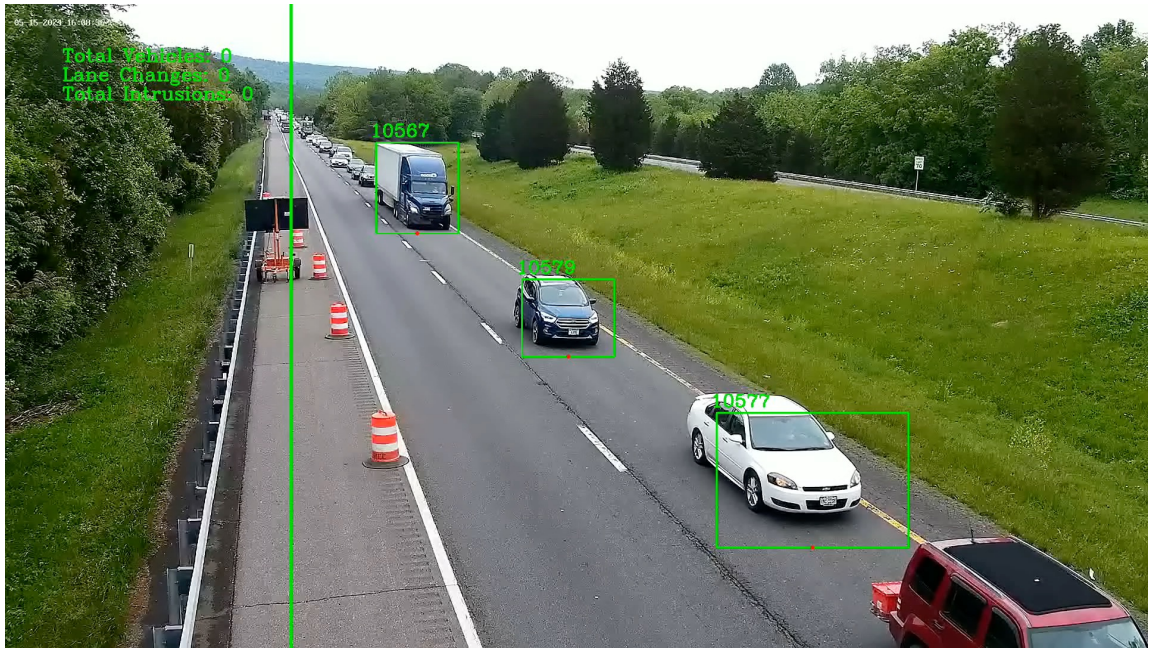
Equipment Unit

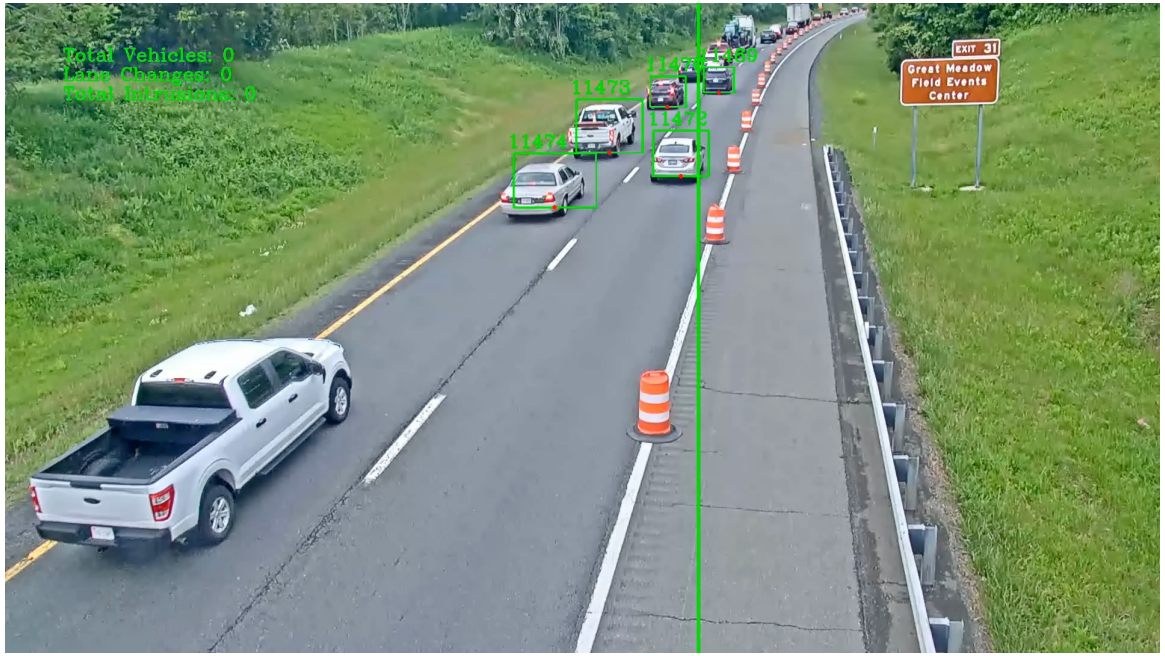
- Magnetic base attaches quickly to equipment
- Wireless mesh network integrates with base station
- GPS+RTK module
- Inertial measurement unit
- Provides warnings to workers when they are close and equipment starts moving

Traffic Evaluation System

- Developed a machine-vision based system that can be mounted on roadside
- Initially used to assess compliance with Move Over Law
- Developed into warning solution for roadside workers based on trajectory of approaching vehicles
- Integration into fixed work zone warning systems and scenarios







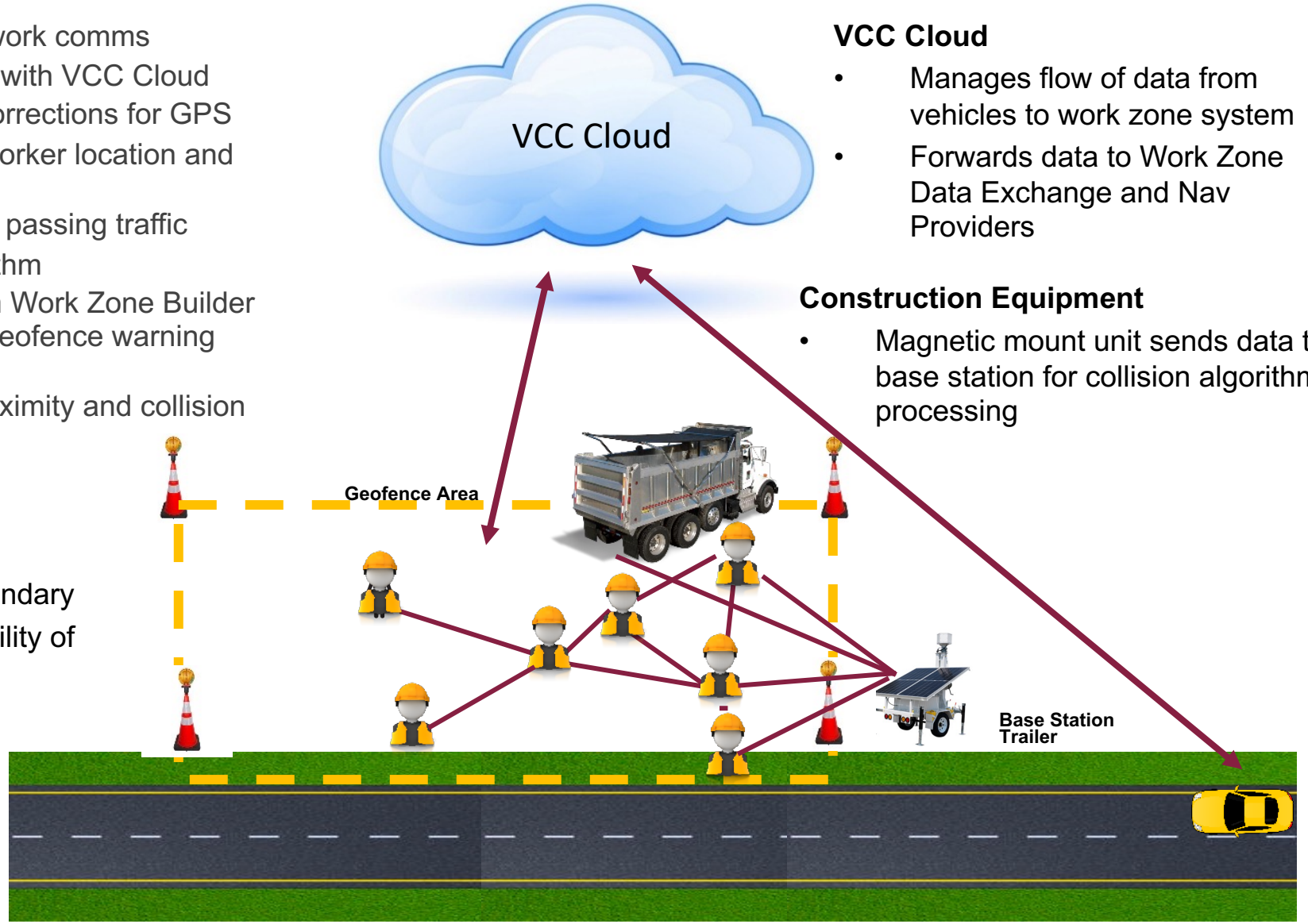
Smart Work Zone Configuration

Base Station Trailer

- Manages wireless mesh network comms
- Manages 4G cellular comms with VCC Cloud
- Receives and applies RTK corrections for GPS
- Processes and aggregates worker location and movement data
- Machine vision processing of passing traffic
- Runs collision warning algorithm
- Receives geofence data from Work Zone Builder and/or geo-plotter and runs geofence warning algorithm
- Sends vests and helmets proximity and collision warnings

Smart Cones

- Auto-define geofence boundary
- Expands range and reliability of mesh network

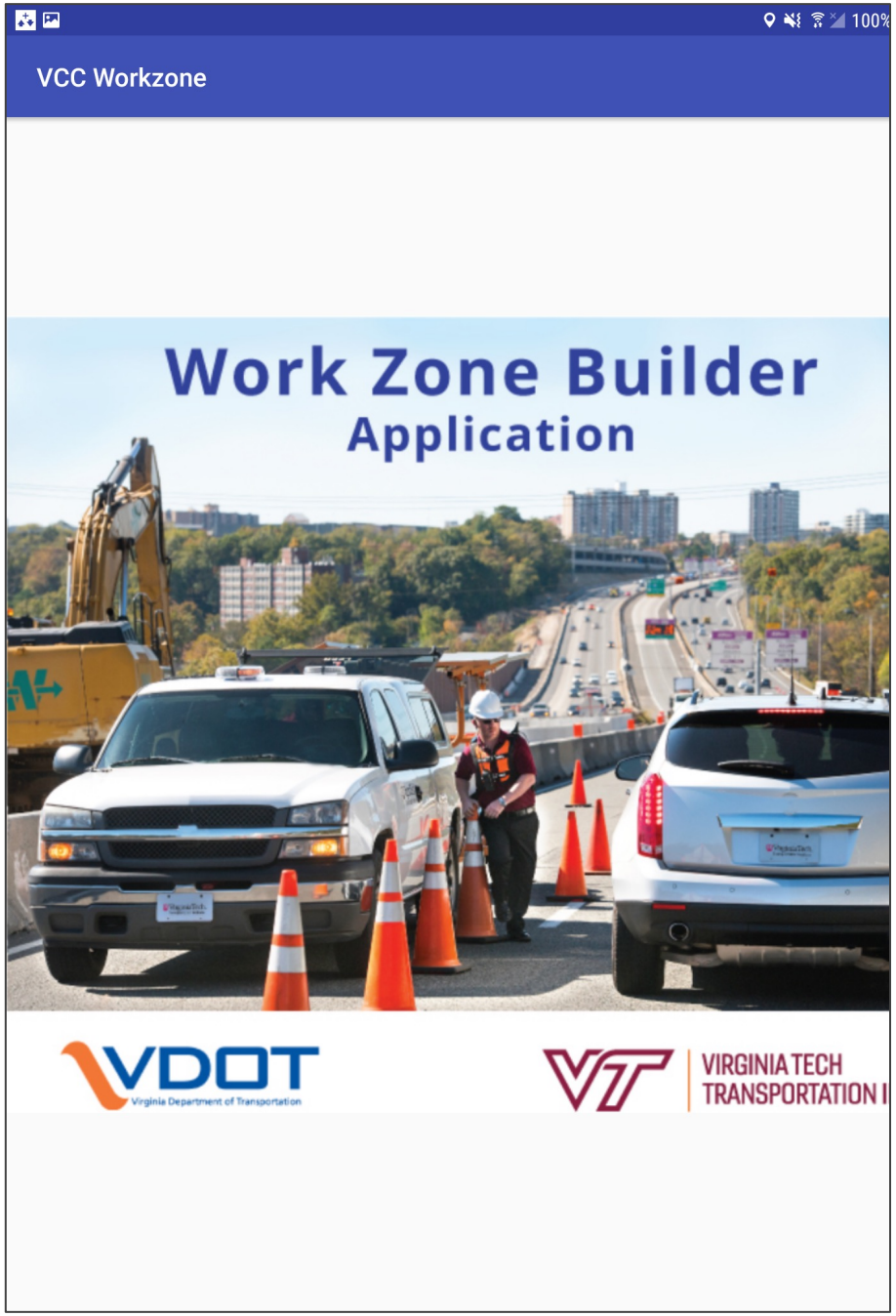


VCC Cloud

- Manages flow of data from vehicles to work zone system
- Forwards data to Work Zone Data Exchange and Nav Providers

Construction Equipment

- Magnetic mount unit sends data to base station for collision algorithm processing

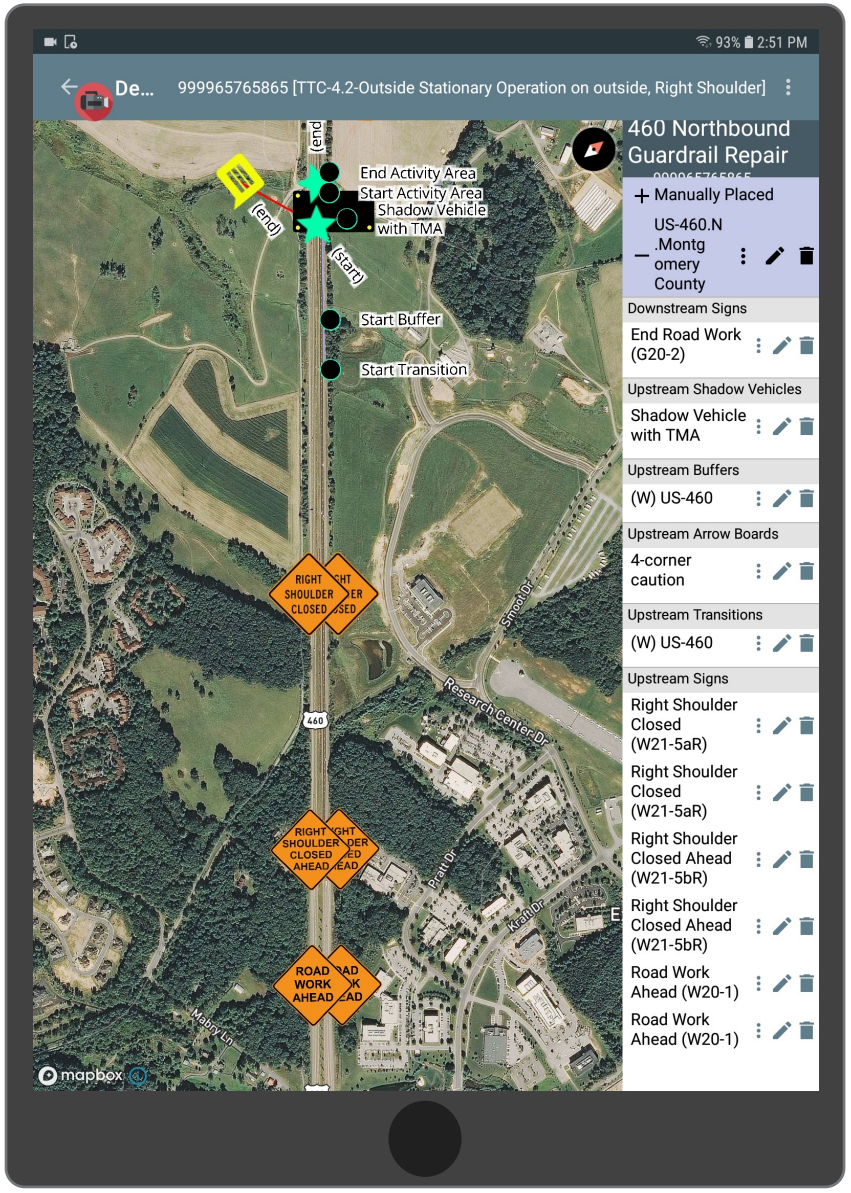


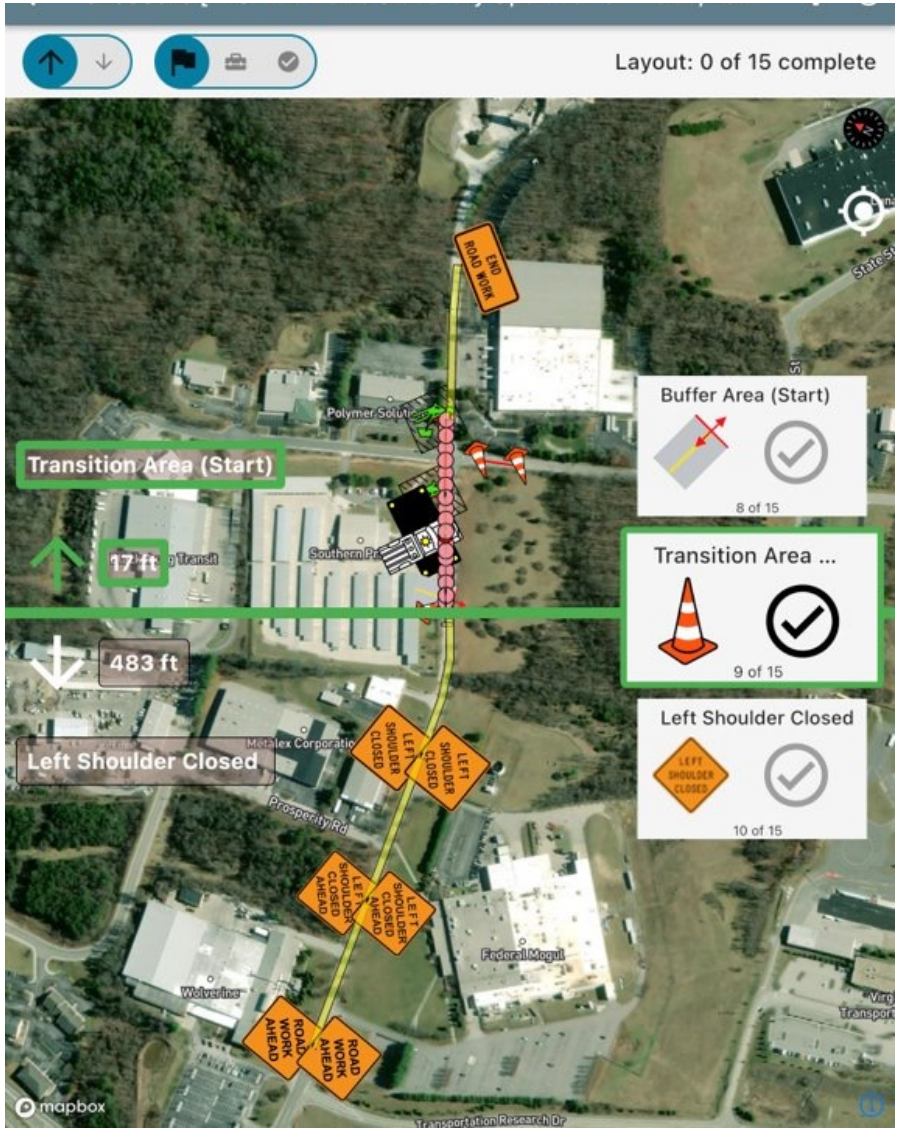
Work Zone Builder Application

- Tablet-based application to create and manage work zone plans
- Produce data that connected and automated vehicles will need to safely navigate work zones
- Streamline submission, review, and approval processes
- Provide a means to source work zone data for **maintenance** activities
- Create an app that work zone managers want to use
- Provide a means to source data for Work Zone Data Exchange and 3rd party navigation applications

Design Mode

- Select activity area and apply TTC template
- Adjust positions of existing features
- Add new features from palette
- Mirror inside / outside templates
- Clone bi-directional templates
- Add notes to features
- Automatically add geofenced areas that will integrate with Smart Vest system





Field Mode

- Use GPS to navigate to, position, and validate work zone features
- Update plans to reflect field adjustments made to address site conditions
- Communicate status electronically to TOC
- Capture imagery to further document the design

Automated TMA Program

- Consortia formed to co-fund development of automated TMA prototype
- Freeway operations, HMI, robust safety features
- Multi-phase program
  - Phase 1: Design, build, and demo leader-follower ATMA System (complete)
  - Phase 2: GPS-Denied operations and reduced BOM (complete)
  - **Phase 3: Testing on public roadways in live work zone operations (current)**
- Targeted Outcome
  - IP package suitable for commercialization



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SAFE-D SAFETY THROUGH DISRUPTION

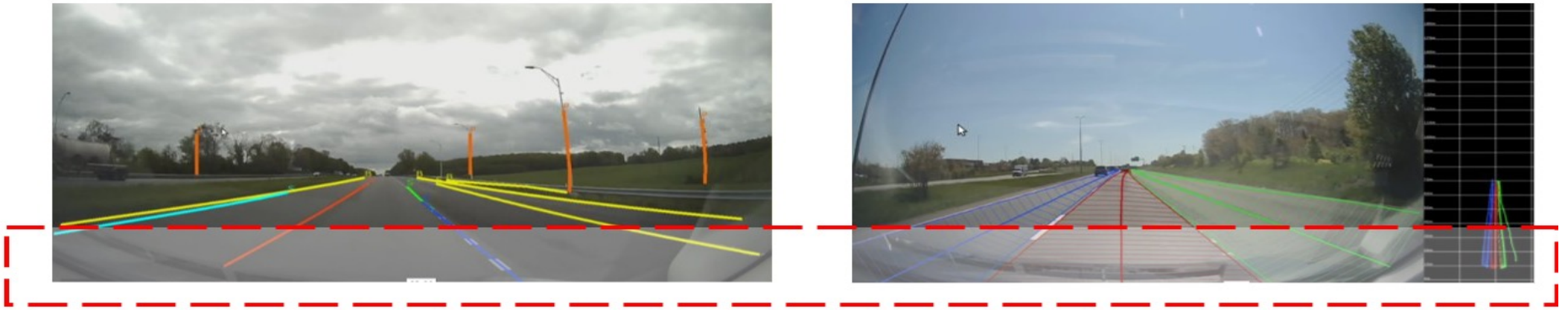
Current Functionality

- Lead-follower operation with portable lead package
- Transferrable lead vehicle package
- Lateral offsets +/- 12 ft, longitudinal offsets of 50 to 400 ft
- GPS-denied operating capability
- Speeds tested up to 40mph, suggested operation 15mph or less
- Manually initiated holds and releases
- Static and dynamic forward object detection and response
- Remote driving capability to circumvent challenges





Most Recent Developments



- Incorporate a machine vision lane line tracking solutions to supplement GPS
- Add safety features to support transition to on-road testing
- Integration with a remote monitoring and operation system
- Reduced BOM and system costs, simplified lead package
- Successful tests completed on US460, I-64, I-564 Tunnel, and with Iowa DOT

Integration into Mainstream Operations

- The big step!
- Building the case for safety
  - Safety by design
  - Safety by consensus
  - Legal and regulatory review
  - Safety through performance
  - Safety in deployment
- **Remove the driver and safety driver** from the most vulnerable TMA position
- Monitor performance and adherence to Operational Design Domain limitations



Next Steps

- Apply learnings from testing with Iowa, Pennsylvania, Virginia on NCHRP Project
- Robust and resilient
- Simple, plug-and-play deployment
- Integration with VDOTs business processes
- Finalize commercialization





Questions?

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