Mike Mollenhauer

Director of the Center for Technology

Dr. Michael Mollenhauer is the Implementation at the Virginia Tech Transportation Institute.

He leads a team of researchers and software engineers that help customers conduct early stage deployment and evaluation of connected and automated vehicle systems.

More recently, Mike is leading VTTI's efforts to partner with the Virginia DOT to develop the Virginia Connected Corridor through the deployment of V2I infrastructure, a cloud computing environment, and a variety of mobile connected vehicle applications.

Connected Vehicle Implementation Activity in Northern Virginia

Virginia Tech
1872
TRANSPORTATION INSTITUTE

Overview Presentation
4/26/2018

Dr. Michael A. Mollenhauer
Director
Center for Technology Implementation
Virginia Tech Transportation Institute

5GAA Automotive Association

VTTI's Role

- Participate in VDOT's planning for CAVs and their impacts on roadway operations
- Provide technical leadership and evaluation services to understand the impact of CAVs
- Facilitate and manage early stage deployment of connected vehicle systems
- Create solutions that bridge gaps in commercially available solutions when necessary

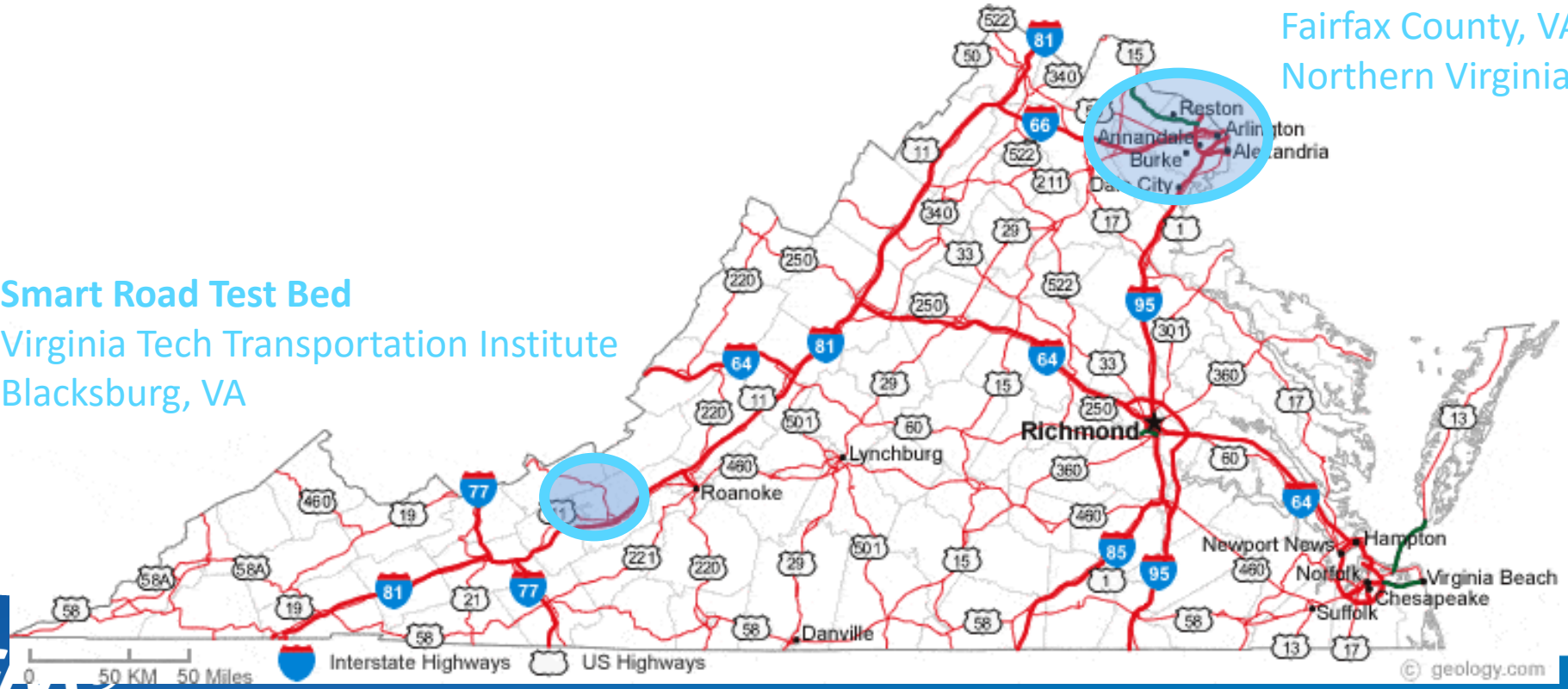
Virginia Connected Corridors

STRATEGY ANALYTICS

Mission: Provide an open environment where connected vehicle concepts can be developed, tested, deployed, and evaluated in real world operating environments.

Northern Virginia Test Bed
Fairfax County, VA
Northern Virginia

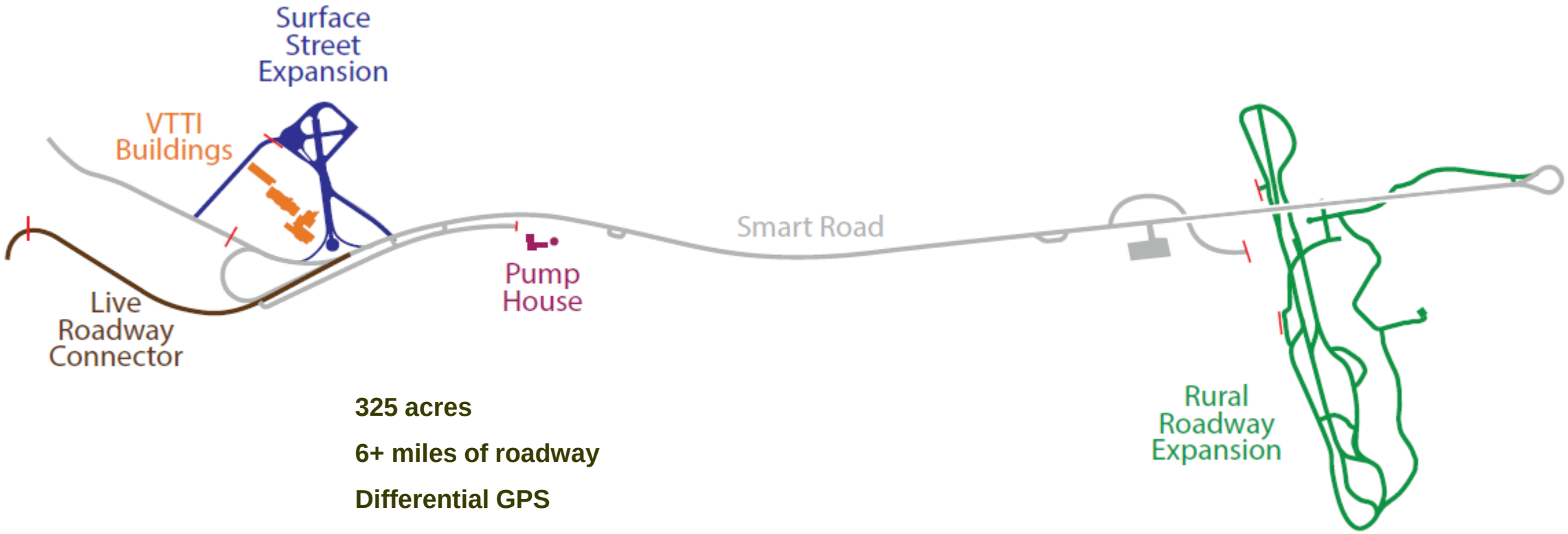
Smart Road Test Bed
Virginia Tech Transportation Institute
Blacksburg, VA



5GAA Automotive Association

VDOT Virginia Department of Transportation

Virginia Smart Road



325 acres

6+ miles of roadway

Differential GPS

Cellular coverage with varying levels of service

Continuous DSRC coverage

Contiguous driving in a mix of environments

STRATEGY ANALYTICS

VDOT Virginia Department of Transportation

Virginia Tech Transportation Institute

- Freeway, rural, and reconfigurable urban roadway sections
- 22,000+ hours of groundbreaking research
- Weather, lighting, diverse pavement, intersection

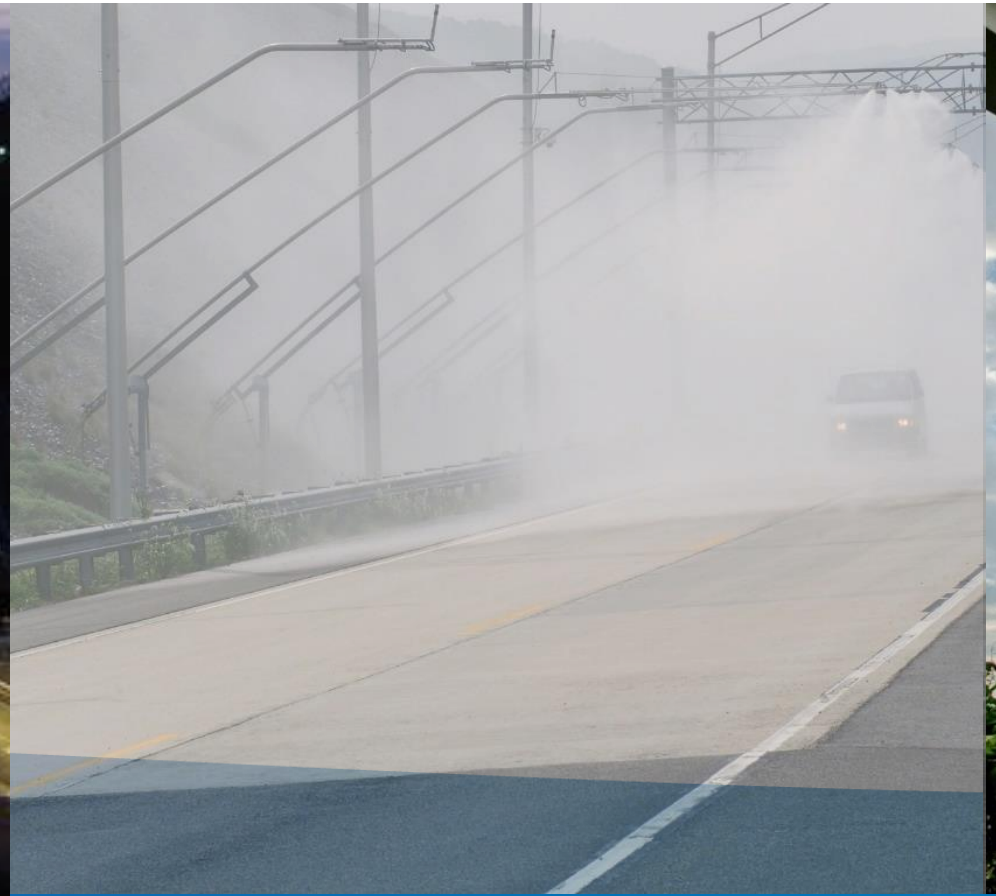


photo by Michael Kiernan

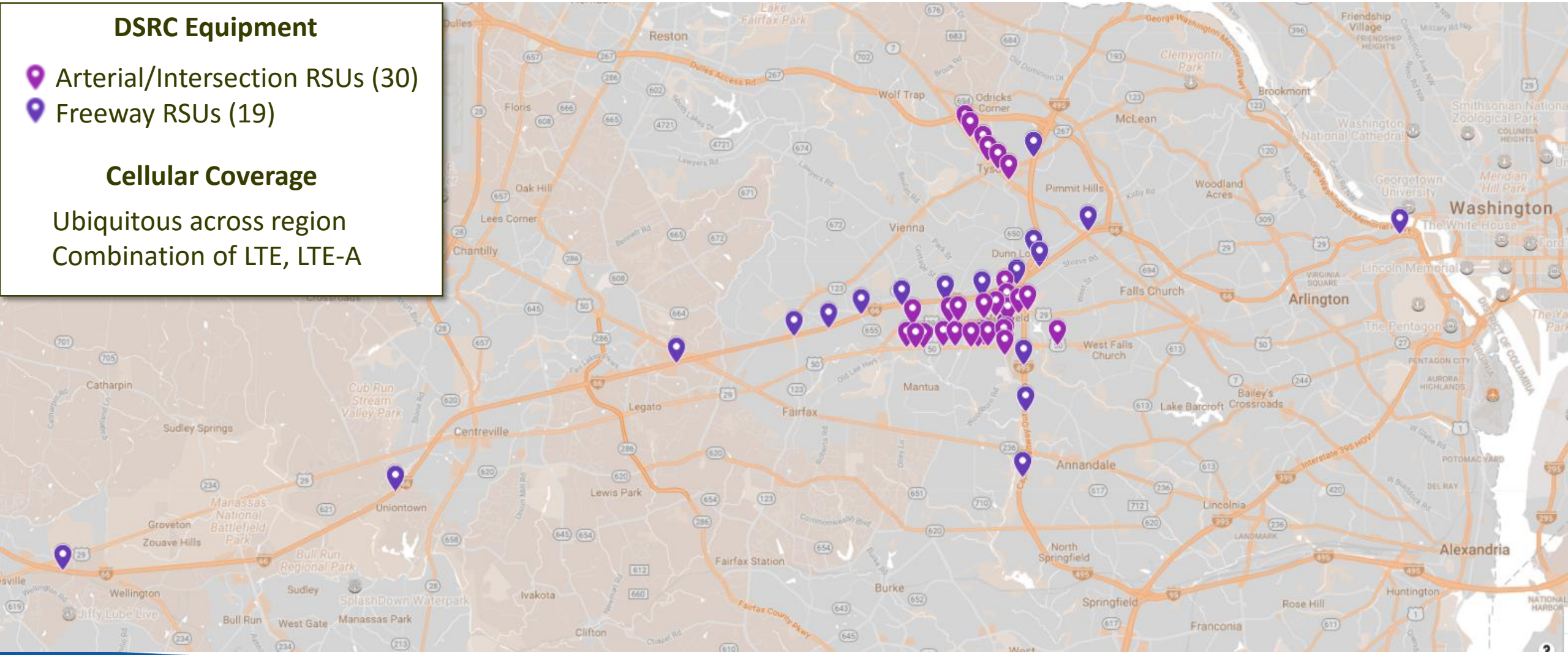
Northern Virginia Test Bed

DSRC Equipment

- Arterial/Intersection RSUs (30)
- Freeway RSUs (19)

Cellular Coverage

Ubiquitous across region
Combination of LTE, LTE-A



Northern VA Challenges

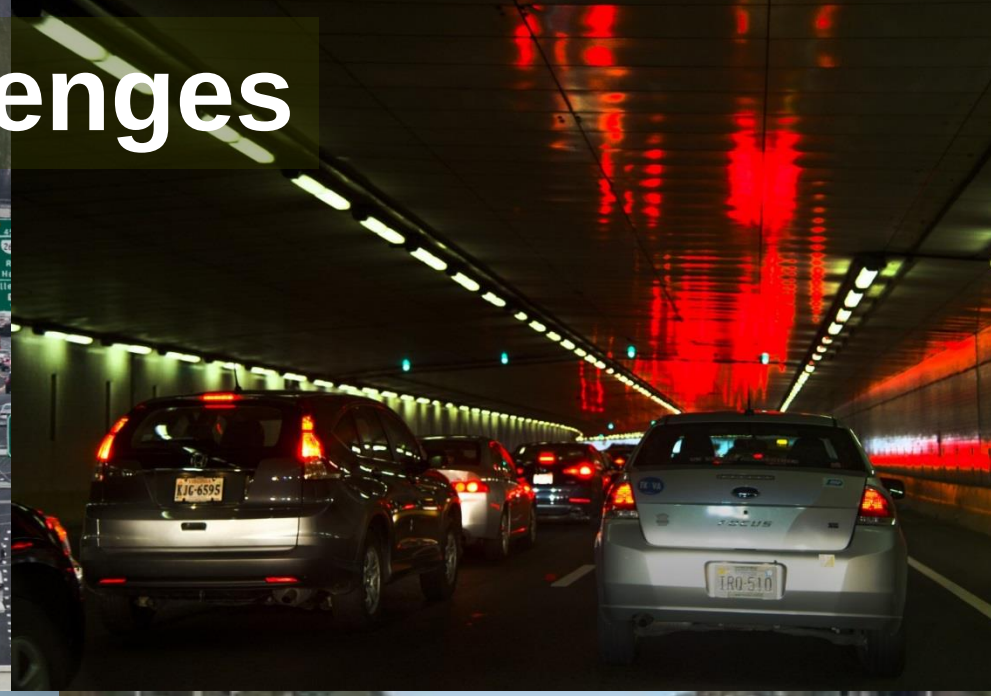


Photo: Courtesy WTOP

The VCC is Communications Agnostic

- Current Communications Capabilities
  - Dedicated Short Range Communications (DSRC)
  - 3G/4G Cellular
- Anticipated Future Capabilities
  - C-V2X
  - 5G Cellular
- VTTI characterizes the performance of the communications capabilities available on the test bed environments
- VCC deployments seek to assess the impacts of communication technology characteristics on the individual CAV applications

Prototype and Proof of Concept

Real World Challenges

VCC Cloud

- Application Processing
- Data Hub Management
- External Data Interfaces
- Cellular and DSRC

Design & Test

Smart Road

- 2.5 mile Test Track Facility
- Intersection, Ramps, Bridge
- Controlled Weather and Lighting

CV Message Traffic

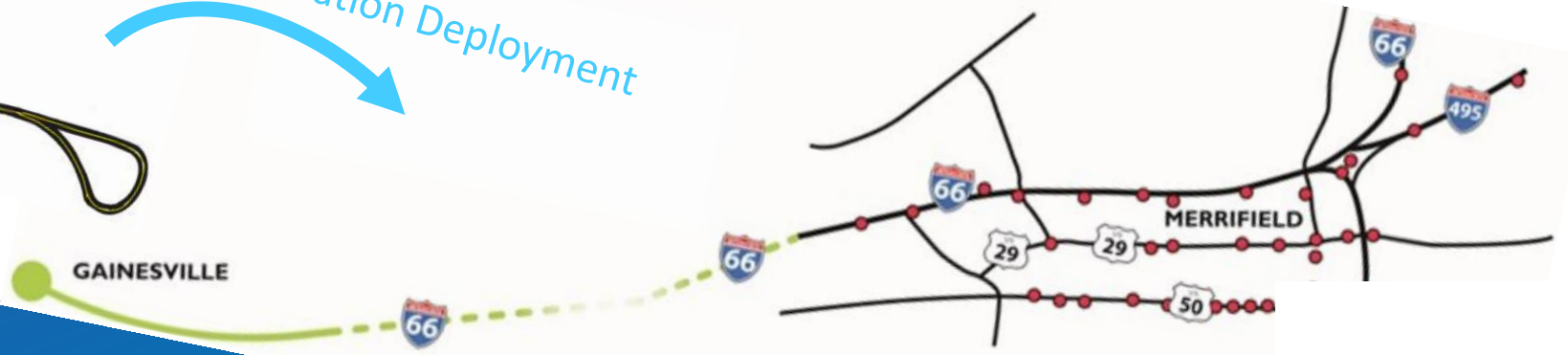
CV Message Traffic

Deploy & Evaluate

Northern VA Test Bed

- Heavily Congested Arterials and Freeways
- Interface to VDOT Northern Region TOC
- ATM, VDMS, HOVs, Toll Lanes, Ramp Meters

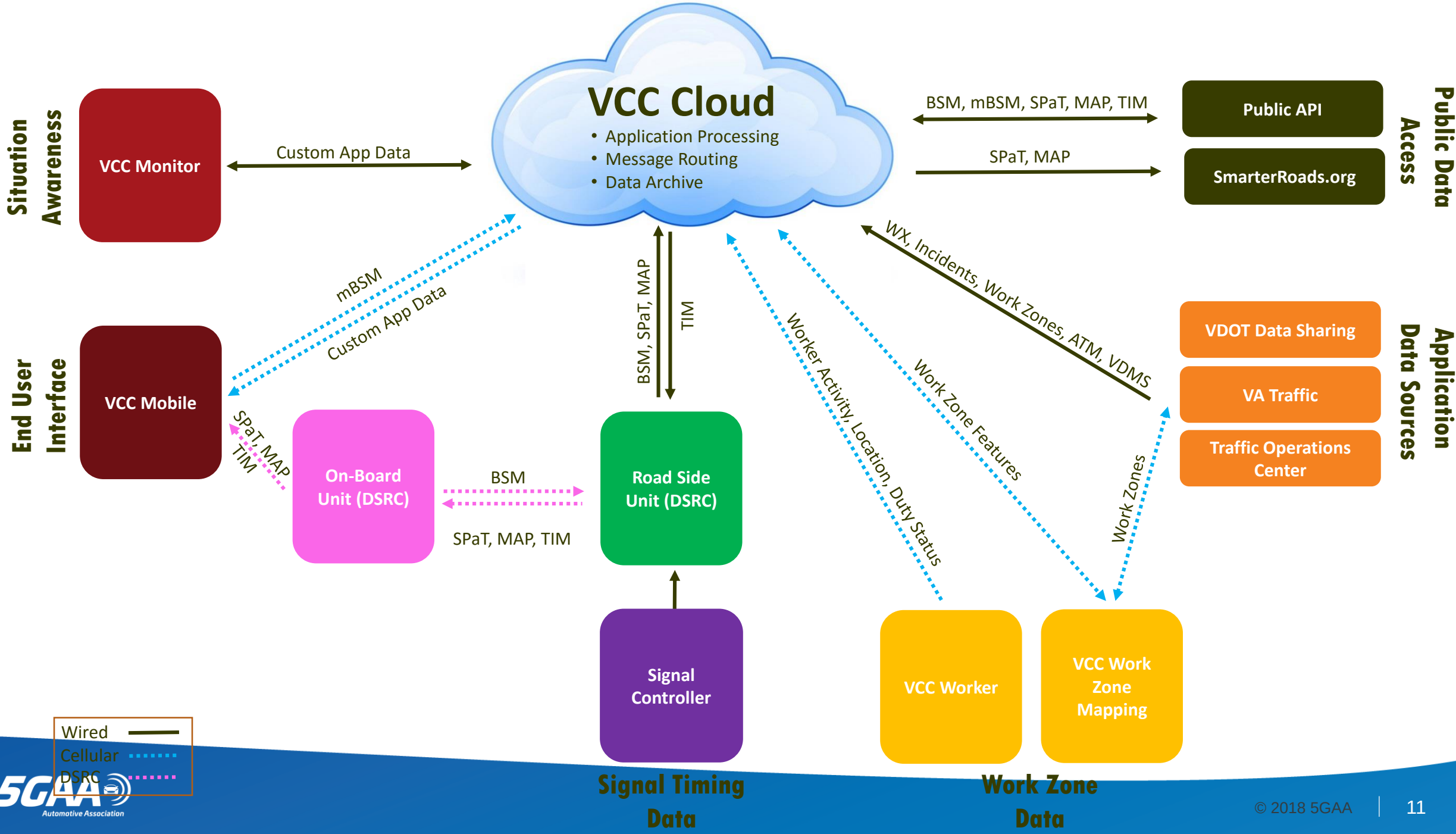
Systematic Application Deployment



VDOT

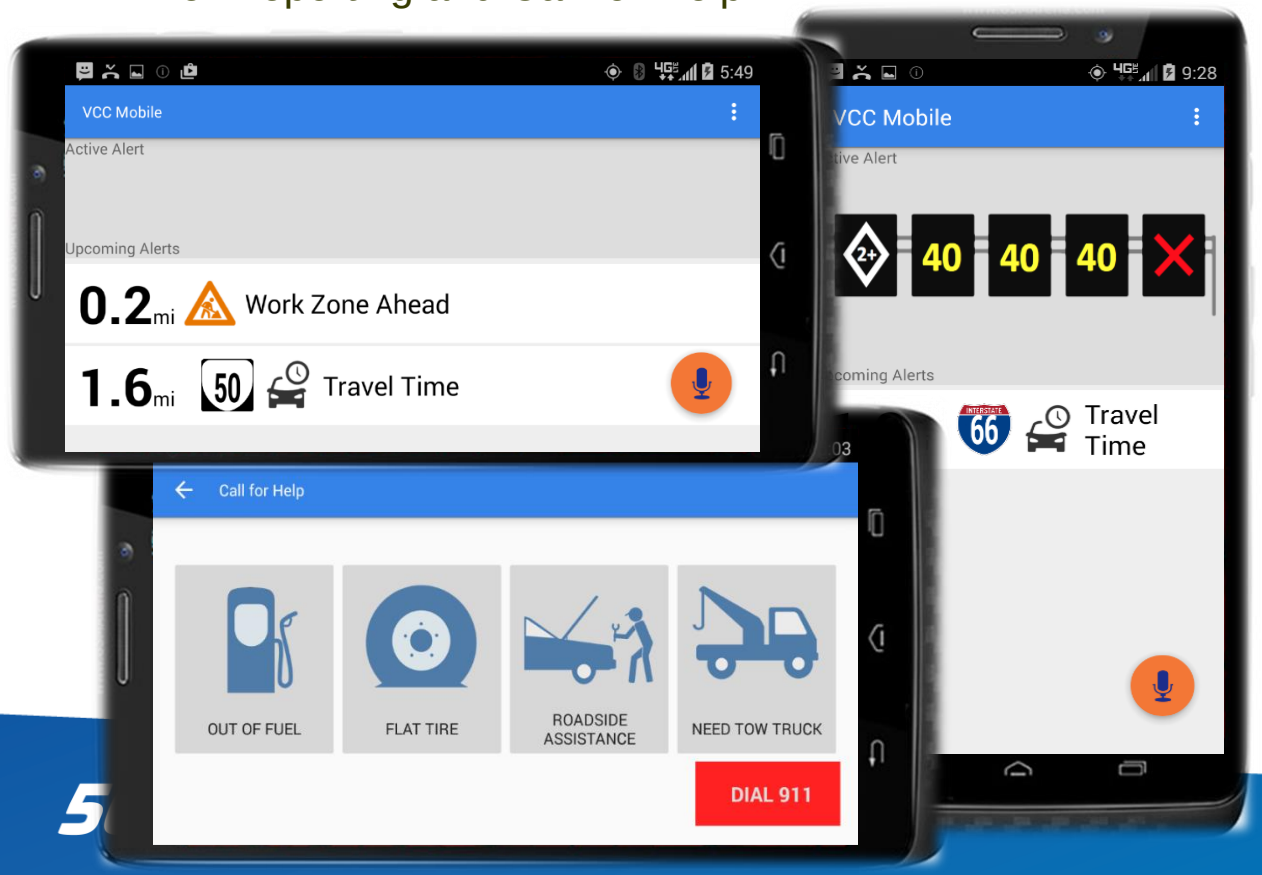
VTRC
Virginia Transportation
Research Council

Virginia Tech
Transportation Institute


Situation Awareness
VCC Monitor
Custom App Data
VCC Cloud
• Application Processing
• Message Routing
• Data Archive
BSM, mBSM, SPaT, MAP, TIM
SPaT, MAP
Public API
SmarterRoads.org
Public Data Access
mBSM
Custom App Data
BSM, SPaT, MAP
TIM
WX, Incidents, Work Zones, ATM, VDMS
End User Interface
VCC Mobile
SPaT, MAP TIM
On-Board Unit (DSRC)
BSM
SPaT, MAP, TIM
Road Side Unit (DSRC)
Worker Activity, Location, Duty Status
Work Zone Features
Work Zones
VDOT Data Sharing
VA Traffic
Traffic Operations Center
Application Data Sources
Signal Controller
VCC Worker
VCC Work Zone Mapping
Wired
Cellular
DSRC
Signal Timing Data
Work Zone Data

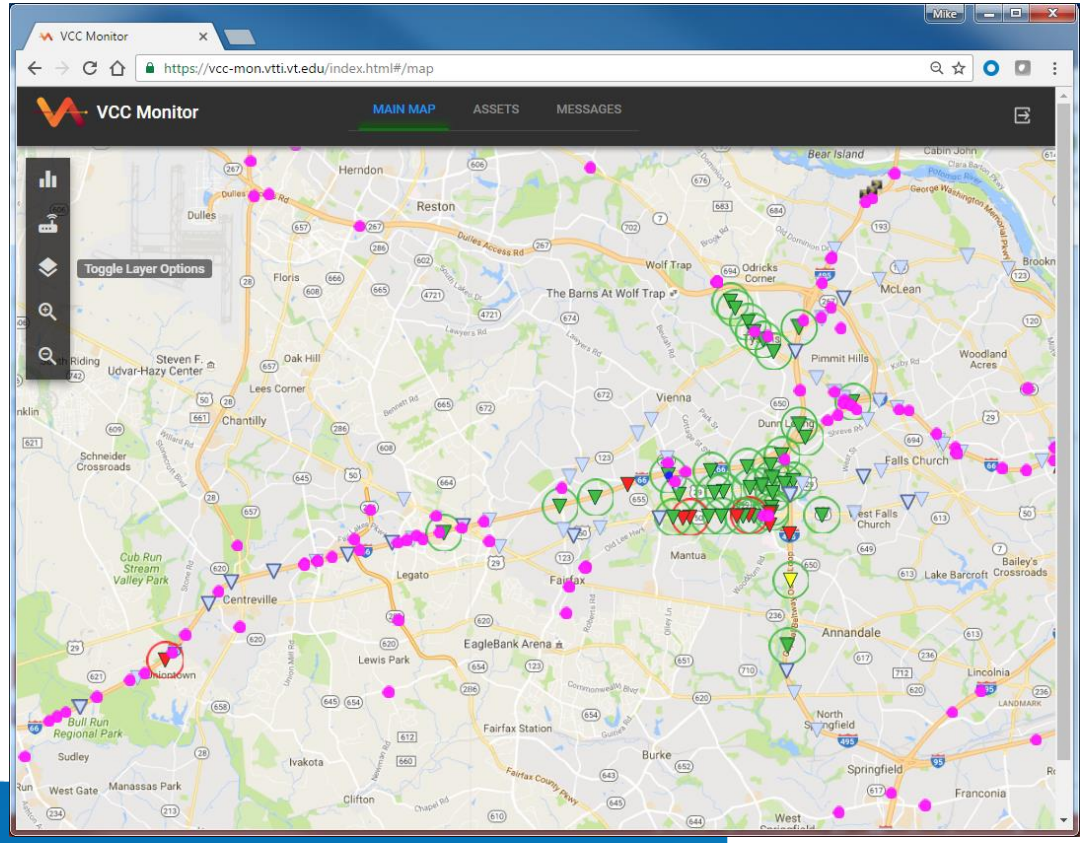
VCC Mobile

- Cellular or DSRC/OBE
- Dynamic Driver Messaging
- Work Zone Alerts
- Weather Advisories
- Traffic Incidents
- ATM/HOV Status and Alerts
- Pot Hole Detection and Road Surface Temp Monitoring
- Driver Reporting and Call for Help



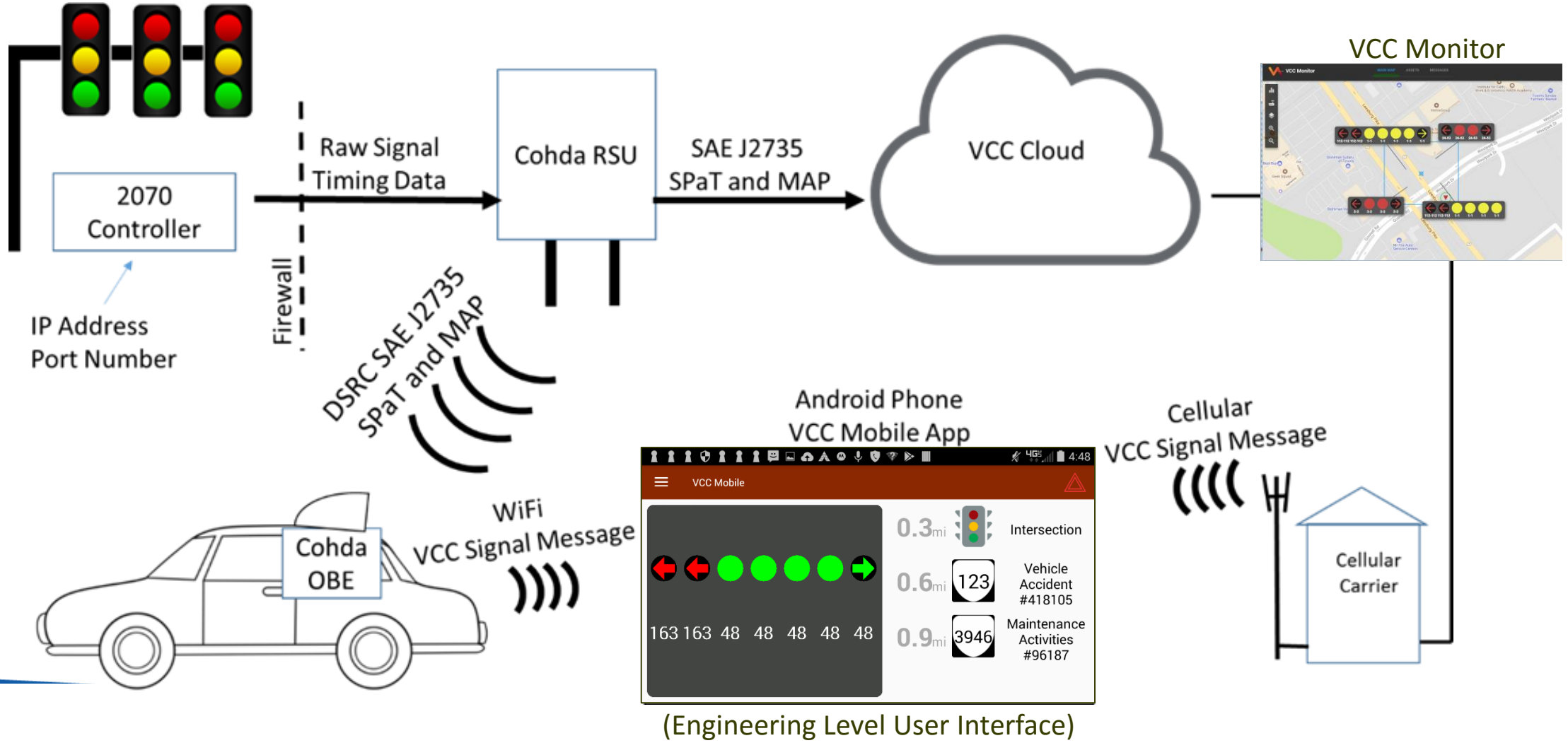
VCC Monitor

- Realtime Situation Awareness Tool
- RSU Status and Performance Monitoring
- Message Flow Monitoring (BSM, BMM, PDM, TIM, etc.)
- SPaT Status Display
- Control Message Management
- Traveler Information Message Management
- Driver Report Location



SPaT Implementation

Each of 4 arterial corridors (US50, US29, Rt 7, Rt 650) has at least 6 and as many as 11 consecutive intersections

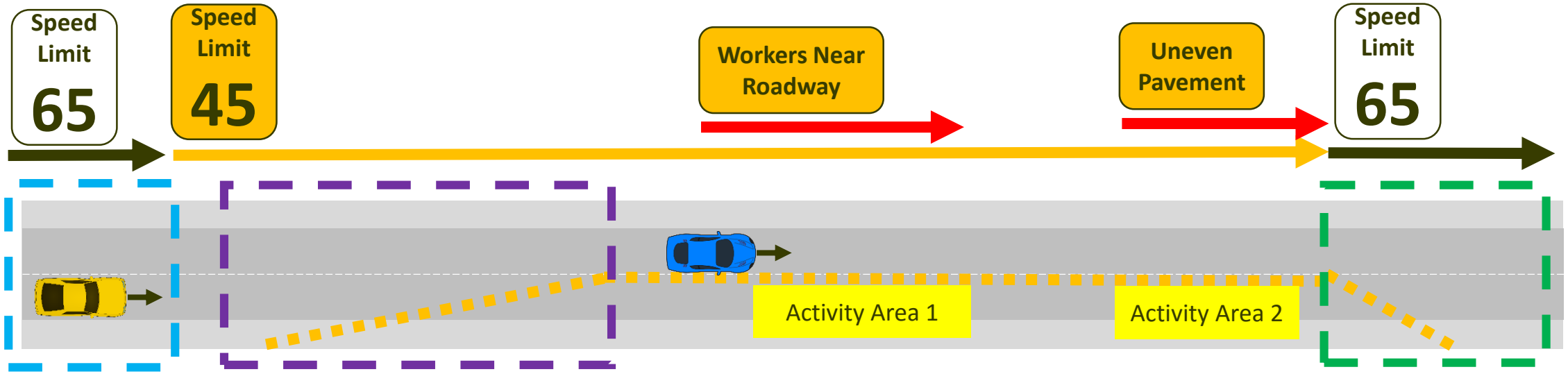


(Engineering Level User Interface)

Focus: Work Zone Safety

- VDOT is interested in how CAVs will affect work zone safety
  - Can CV messaging be used to improve safety?
  - What are the data requirements future CAVs and how can it be managed?
- VTTI is working to develop an end-to-end solution for evaluating concepts to improve safety
  - Multiple projects pieced together to work towards a solution to evaluate in the field
  - Work with existing VDOT systems to extend capability
  - Build systems to address gaps in technology and data
  - Test and evaluate novel solutions

Desired CAV Data Elements



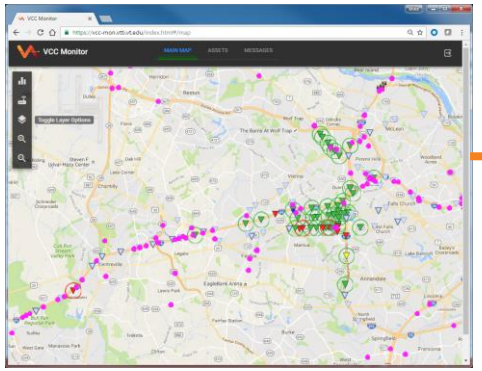
Approach
- Lat / Lon Geo Position
- General Description
- Operational Restrictions

Transition
- Lat / Lon Geo Position
- Beginning of Taper
- End of Taper
- Required Actions
- Merge Direction
- Lanes Offsets / Alternate Paths
- Speed Reduction
- Maneuver Restrictions

Activity Area(s)
- Lat / Lon Geo Position
- Description
- Potential Hazards
- Barrier Type
- Active / Inactive

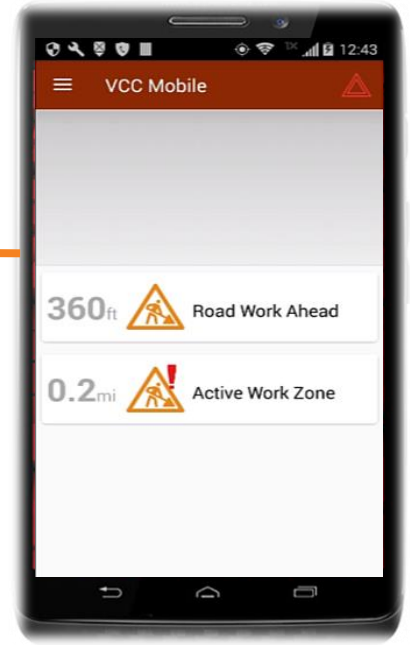
Termination
- Lat / Lon Geo Position
- Beginning of Taper
- End of Taper
- Resume Speed Limit

VCC Work Zone Components

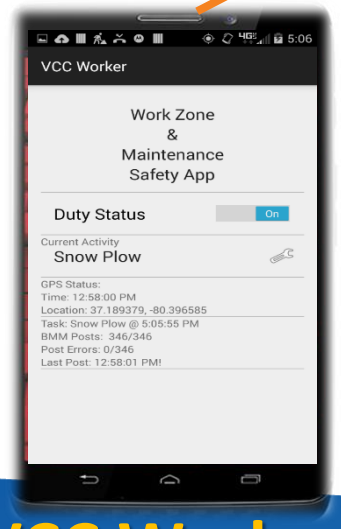


VCC Monitor
Situation Awareness

VCC Cloud
Data and Processing Hub

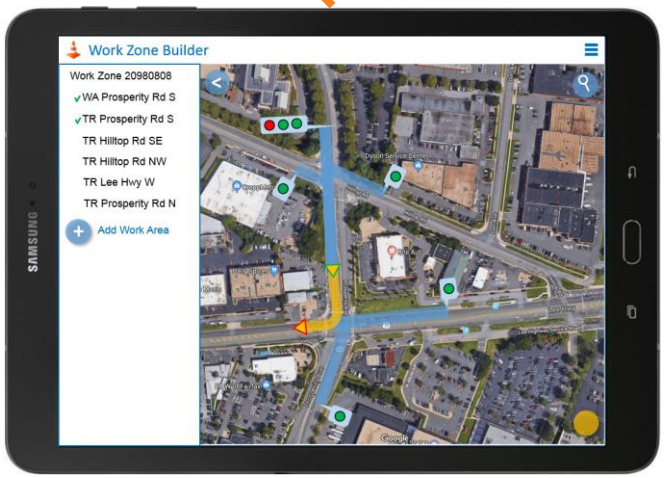


VCC Mobile
Driver Interface



VCC Worker
Dynamic Worker Location and Activity

VCC Vest



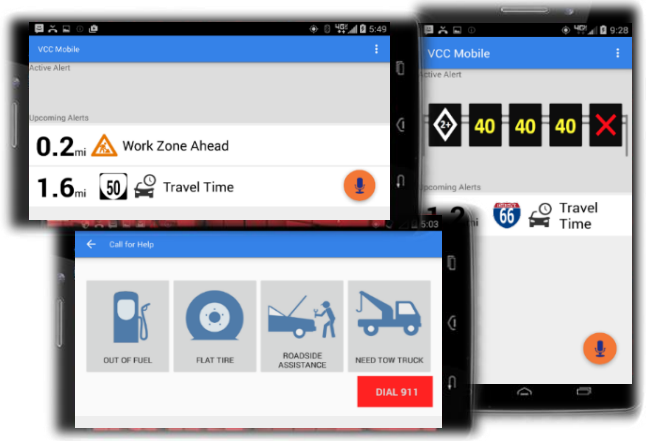
Work Zone Builder
Detailed Work Zone Definition

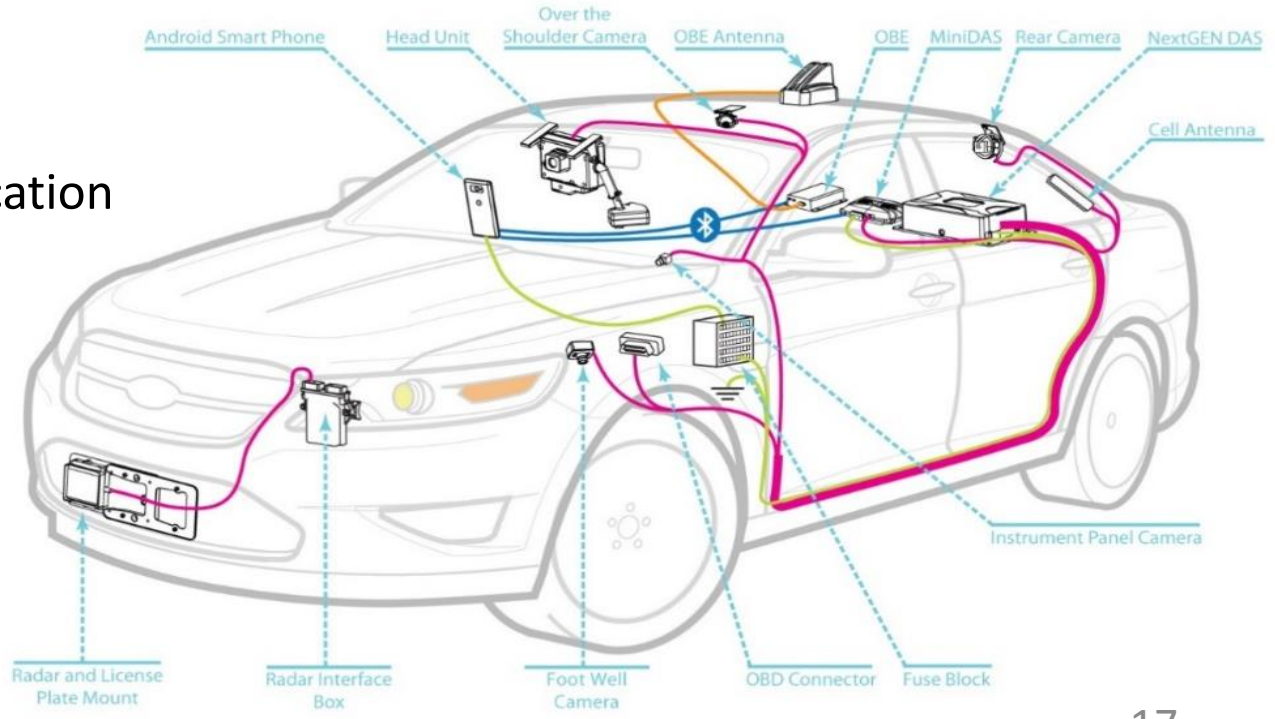
VCC L2 “Elite” NDS

Purpose: Build naturalistic dataset to assess behavior with early production L2 vehicles and responses to a mobile CV application

Details:

- 50 personally owned production L2 and ADAS equipped vehicles
- 12 months of data collection
- Use of connected vehicle application on the VCC CV environment
- Evaluating drivers interactions with technologies
- Early look at production level 2 automated vehicles





Equipped Vehicles

- 11 – Tesla Model S
- 1 – Tesla X
- 2 – Acura RDX
- 1 – Acura MDX
- 2 – Acura TLX
- 3 – Jeep Grand Cherokee
- 4 – Hyundai Genesis
- 3 – Hyundai Sonata
- 1 – Ford Flex
- 4 – Ford Fusion
- 1 – VW Passat
- 5 – Honda Accord
- 1 – Honda Civic
- 1 – Cadillac SRX
- 1 – Mercedes CLS550
- 1 – Nissan 300ZX
- 3 –Toyota Highlander
- 1 – Toyota RAV4
- 1 – Volvo S90
- 1 – Volvo XC 90
- 2 –Chrysler Pacifica Limited
- 1 – Chevrolet Suburban

Questions?

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