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Route 9 SPaT Challenge / Connected Vehicle Corridor Project

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Overview

- Project overview
  - SPaT challenge
  - Project Goals
  - Corridor selection
- Design
- Technology
- Next steps
- Partnership opportunities
- Questions

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Project Overview

- Pilot Project that satisfies the **SPaT Challenge** criteria and supports future connected vehicle applications
- 38 intersections under MassDOT jurisdiction and control along Route 9
- Project includes design and implementation
- Includes Hybrid DSRC/5G RSU (Roadside Unit)

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- District 3
- District 6
- City of Worcester
- Town of Shrewsbury
- Town of Northborough
- Town of Westborough
- City of Framingham
- Town of Natick
- Town of Wellesley
- MAPC
- CMRPC
- WRTA
- MBTA

What is/was the SPaT Challenge?

Goal: **20 intersections in 50 states by 2020**

Challenge to state and local public sector transportation agencies
Broadcast SPaT messages through deploying DSRC infrastructure
By AASHTO, ITE, and ITS America through the Vehicle to Infrastructure Deployment Coalition

SPaT deployment underway SPaT deployment operational

26	216	2,121
States Committed	Signals Operating	Signals Planned
Number of states committed to respond to SPaT Challenge.	Current number of operating signals.	Number of signals planned for 2018, 2019, and 2020+

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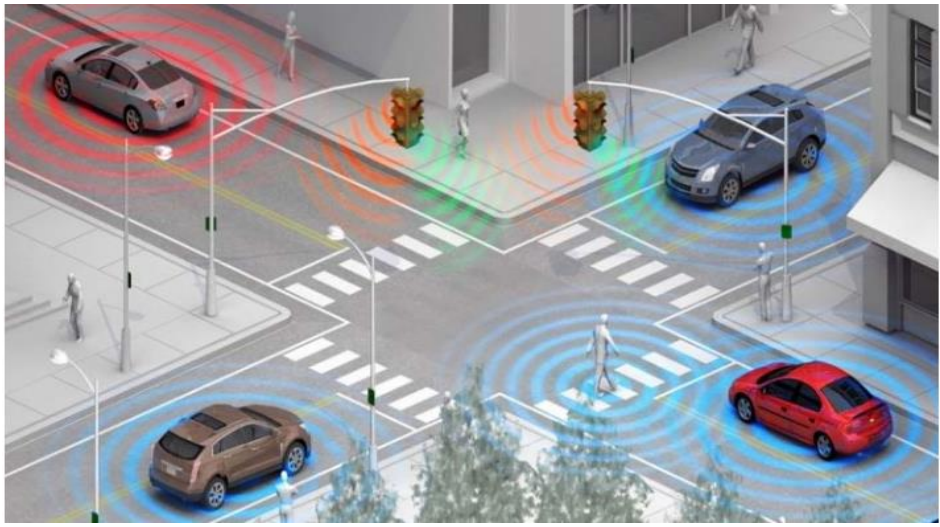
What is SPaT?

Signal Phase and Timing (SPaT) message that defines:

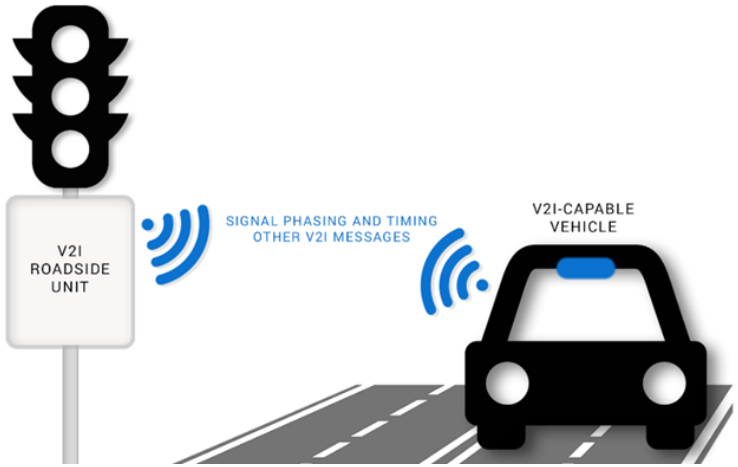
- Current intersection signal light phases
- Current state of signal operation
- Any active pre-emption or priority
- Implemented through C-V2X, 4G-LTE, 5G



This phase of the project will implement the SPaT Infrastructure System at each of the intersections.

Project Vision and Goals

- Satisfy the SPaT Challenge criteria
- Take a tangible first step for deploying vehicle-to-infrastructure (V2I) applications
- Promote future, more advanced vehicle-to-everything (C-V2X) applications
- Demonstrate a commitment to the C-V2X deployments planned by automobile manufacturers
- Provide foundation for future safety, mobility, and environmental applications for all modes



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Project Vision and Goals (continued)

- Access to Signal Performance Measures (SPMs)
- Use redundant cloud-based computing to remotely monitor and manage the traffic signal operations in real time

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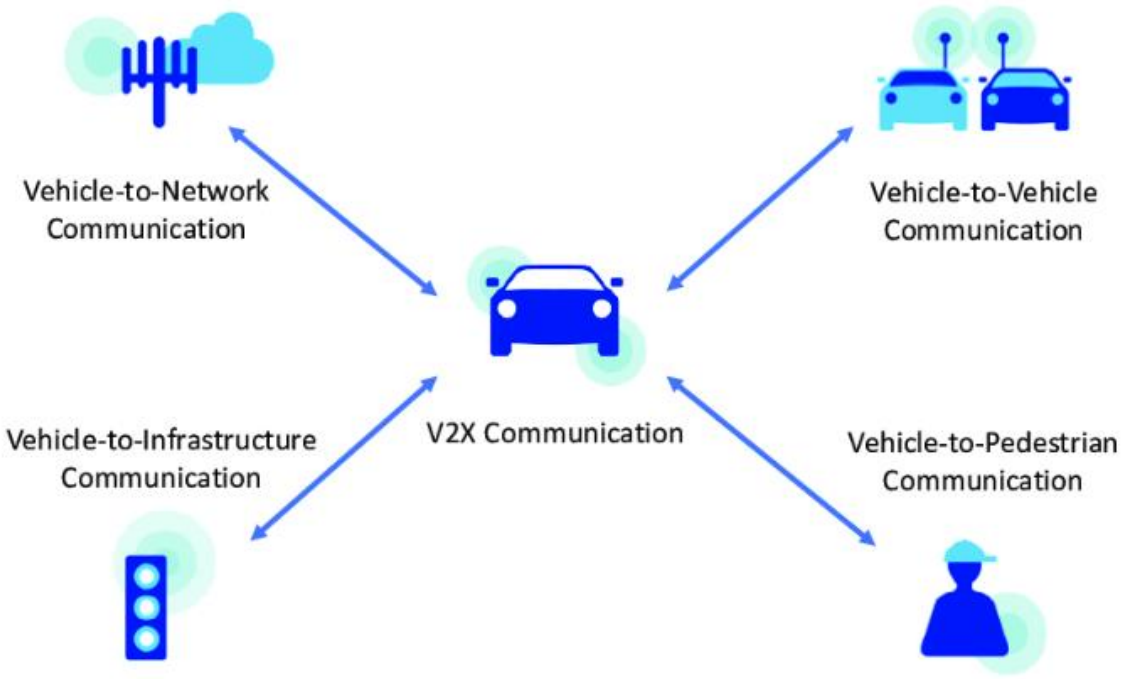
Long Term Vision

- Provide for future C-V2X applications such as safety, mobility and environmental operations
- Use redundant cloud-based computing to monitor and manage the traffic signal operations in real time to improve traffic flow
- Lay the foundation for additional C-V2X deployments

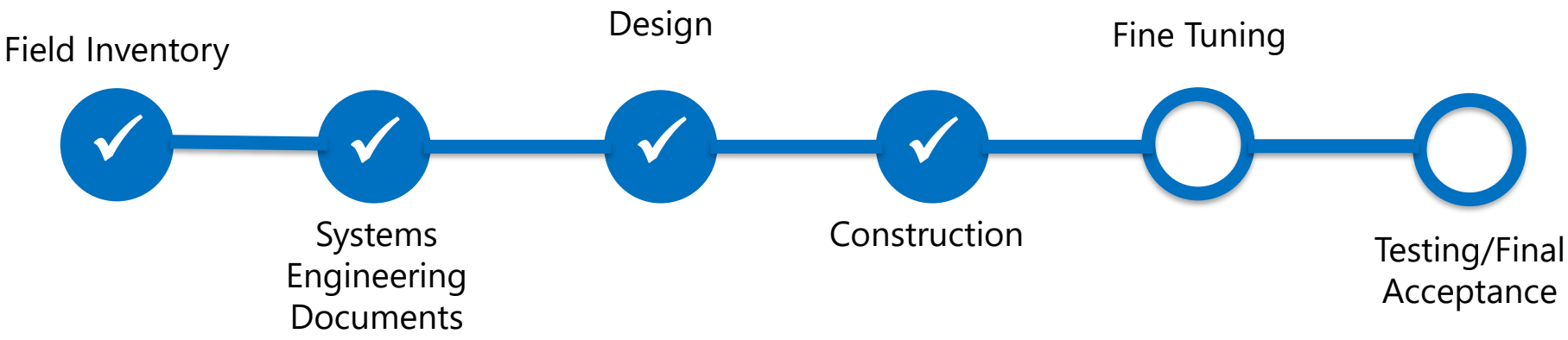


Why Route 9?

- All signals MassDOT-owned and maintained
  - Includes interconnected and standalone traffic signals
- Many signals include emergency vehicle preemption systems
- Operates at or near-capacity during peak periods
- Runs parallel to the MBTA's Worcester Commuter Rail line and Interstate 90

Phased Approach

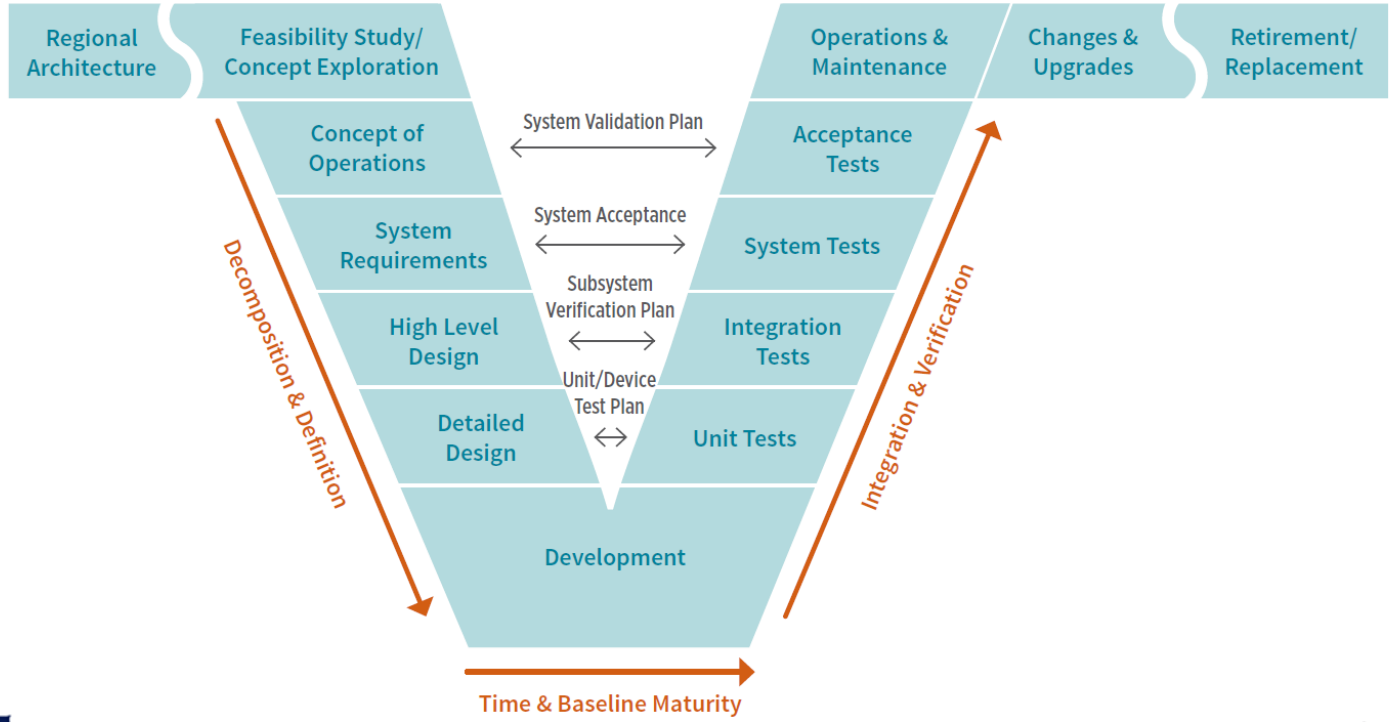
- Phase 1 – Signal System Upgrade



- Phase 2 – Develop and apply connected vehicles applications

Systems Engineering Process

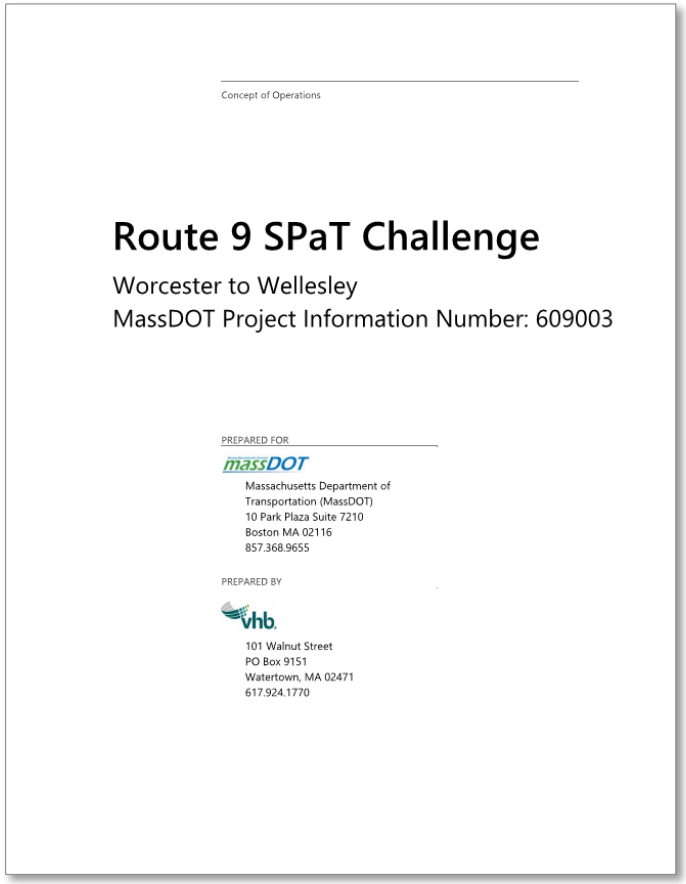
- Agencies encouraged to consider a systems engineering approach towards planning and implementation
- Initial steps include development of a Concept of Operations (ConOps) document and related system requirements



Systems Engineering Process

Concept of Operations

- **System overview** describes expected operations of proposed SPaT infrastructure system
- **Stakeholder needs** describe a challenge facing a stakeholder
- **Operational concepts** are developed based on the needs and are the primary source for the **functional requirements**
- **Operational scenarios** illustrate the expected operation of a SPaT infrastructure system communicating to vehicles and PIDs using CV communications and interface with local traffic signal systems



Concept of Operations

Route 9 SPaT Challenge

Worcester to Wellesley
MassDOT Project Information Number: 609003

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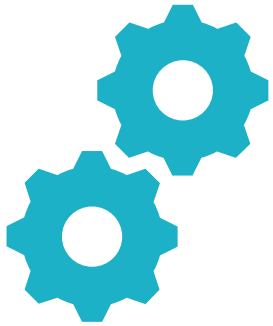
Systems Engineering Process

Functional Requirements



- Functional requirements *(what the system shall do)*
- System architecture and communications requirements
- Performance requirements
- Non-functional requirements *(reliability, safety, environmental)*
- Enabling requirements *(production, development, testing, training, support, development, and disposal)*
- Constraints *(technology, standards, existing conditions)*
- Interface/Integration requirements *(definition of interfaces, protocols, security)*
- Data requirements *(data elements and definitions)*

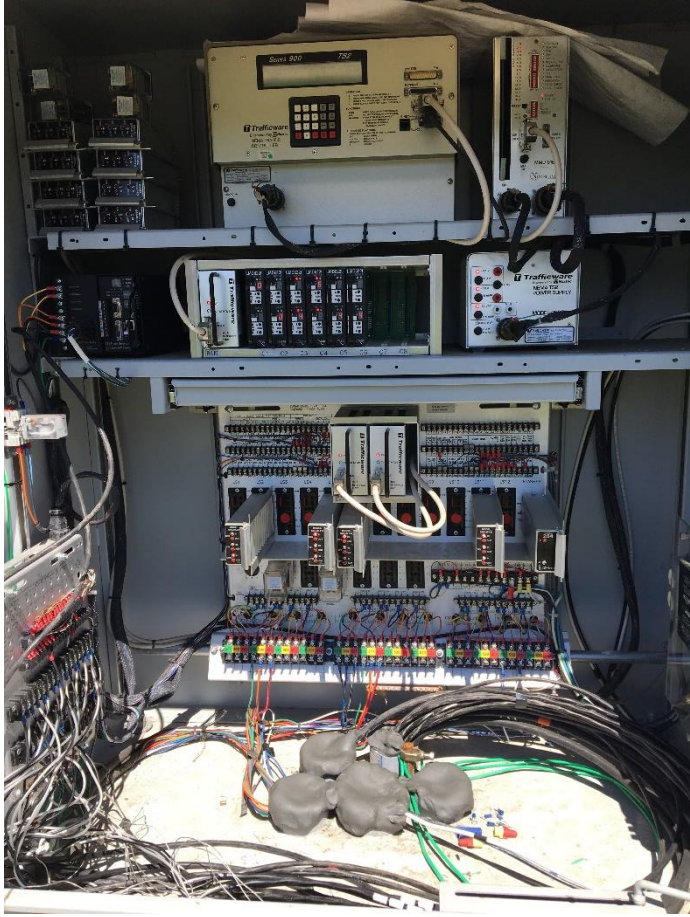
Systems Engineering Process

Design

- Prepared design plans for each location
  - Existing traffic signal installation
  - Proposed SPaT system elements
  - Hybrid CV/5G antenna locations
  - In-cabinet equipment
  - Single Point Detection (360)
  - System communications
  - Expansion of existing adaptive signal control system
- Prepared equipment specifications
- Prepared project cost estimate
- Prepared a final RFP document

Field Inventories

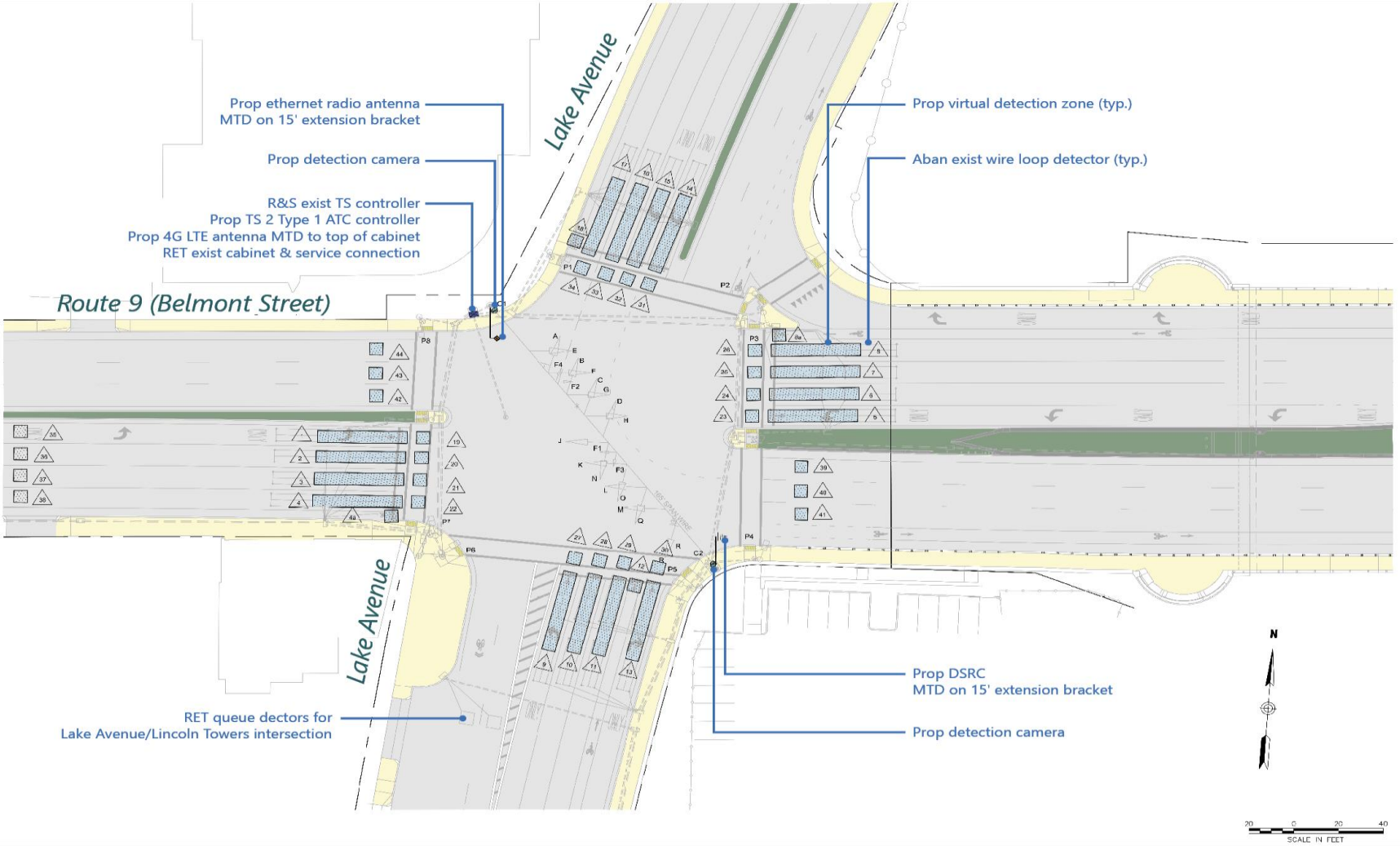
- Conducted in Spring 2019:
  - Control cabinet devices
  - Vehicle detection systems
  - System communications
  - Operations review
  - Identify equipment mounting locations



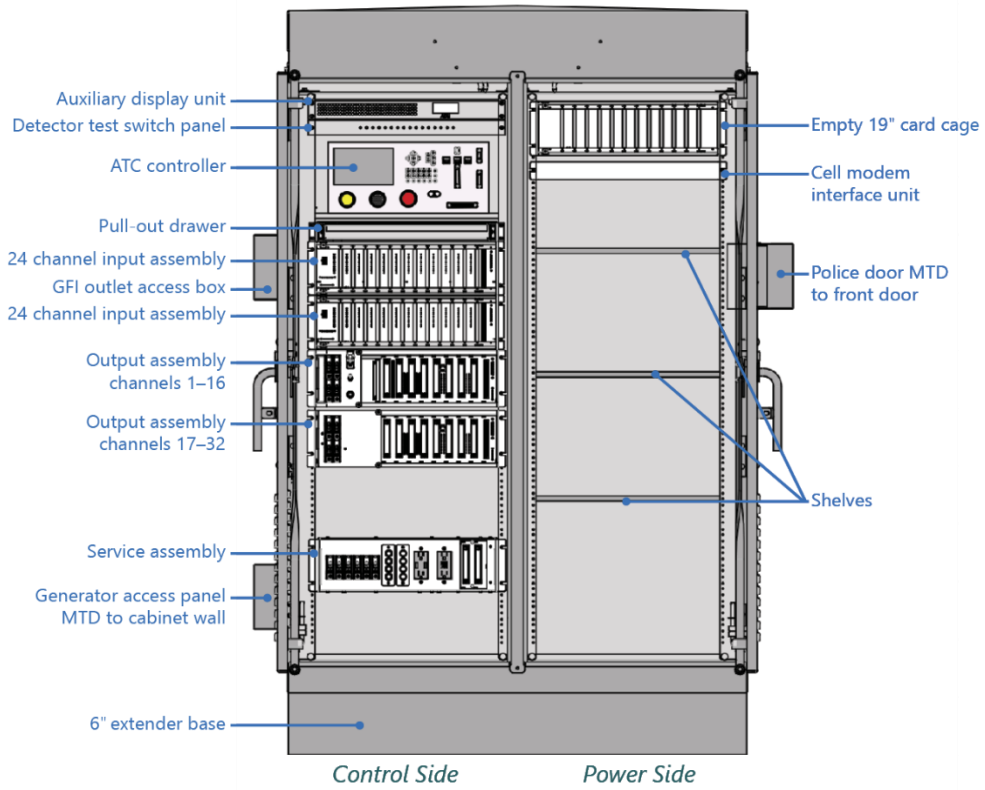
MassDOT Route 9 SPaT - May 2019

Loc. No.	City/Town	MassDOT District	Intersection	Controller	Available Ethernet Port	Retain	Age of Cabinet Assembly	Retain	Existing Operation	Proposed Operation	Comm Drop	Existing Vehicle Detection	Detection Software	Faults	Dilema Zone	Existing Communications	Other Equipment	Notes
1	Worcester	3	Lake Ave/ Lake Ave N	Siemens m50	Y	N	4	Y	Free	Adaptive	N	Loop	N/A	N	N	2-Fiber (future use)	CommNet switch	
2	Shrewsbury	3	N/S Quinsigamond Ave	Eagle M41	N	N	13	N	Free	Adaptive	Y?	Loop	N/A	N	Y	1 Fiber (future) Yagi	CommNet switch, Enocm modem, HummelEx, Verizon	
3	Shrewsbury	3	Plainfield Ave/ Private Driveway	Siemens m60	Y	N	2	Y	GPS Coord	Adaptive	N	Loop	N/A	N	Y	-	-	
4	Shrewsbury	3	Svenson Rd/ Harrington Ave	Siemens m60	Y	N	2	Y	GPS Coord	Adaptive	N	Loop	N/A	N	N	-	-	
5	Shrewsbury	3	Maple Ave	Eagle M41	N	N	9	N	Free	Adaptive	N	Video	Vantage Edge 2	Phase 4	N	-	Video monitor	
6	Shrewsbury	3	Oak St	Naztec 900	Y	N	3	Y	Free	Adaptive	N	Thermal	Flir Traficon 3D,2S	N	N	-	Video monitor	
7	Shrewsbury	3	Lake St	Trafficware 900	Y	N	3	Y	Free	Adaptive	N	Thermal	Flir Traficon 3D,2S	N	N	-	Video monitor	
8	Shrewsbury	3	South St	Siemens m50	Y	N	9	N	Free	?	N	Loop/Video	Vantage Edge 2	N	Y	-	GPS	
9	Westborough	3	Otis St	Siemens m60	Y	N	4	Y	Free	Free	N	Loop	N/A	N	N	-	-	
10	Westborough	3	Rt 9/Speedway Plaza	Siemens m50	Y	N	10	N	Free	Free	N	Loop	N/A	N	N	-	-	
11	Westborough	3	Lyman St	Trafficware 900	Y	N	0	Y	Free	Free	N	Loop/Video	N/A			-	-	UNDER CONSTRUCTION
12	Southboroug	3	Crystal Pond Rd	Econolite ASC 3-1000	N	N	6	N	Free	Free	N	Loops/Gridsmart	Gridsmart	N	Y	-	-	
13	Southboroug	3	Breakneck Hill Rd/ White Eagles	Siemens m50	Y	N	1	Y	Free	Free	N	Loop	N/A	ALL	Y	-	-	
14	Southboroug	3	Oak Hill Rd/ Central St	Eagle M41	N	N	13	N	Free	Free	-	Loop/Video	Iteris Vantage Edge 2	Phase 1,2,6	Y	-	-	
15	Framingham	3	California Ave	Siemens m50	Y	N	9	N	Free	Free	N	Loop	N/A	N	Y	-	-	
16	Framingham	3	Country Club Ln	Siemens m60	Y	N	3	Y	Free	Free	N	Loop	N/A	N	N	-	-	
17	Framingham	3	Temple St	Siemens m60	Y	N	1	Y	Free	Free	N	Loop	N/A	N	N	-	-	
18	Framingham	3	Prospect St/ Main St	Siemens m60	Y	N	1	Y	Free	Free	N	Loop	N/A	Several	N	-	-	
19	Framingham	3	Caldor Rd	Trafficware 980-B140	Y	Y	2	Y	Adaptive	Adaptive	?	Thermal	Traficon TI-X Stream Edge Control Technologies PIM	N	N	1-Copper	ISP Interlone, Copper to Enet	
20	Framingham	3	Ring Rd	Trafficware 980-B140	Y	Y	2	Y	Adaptive	Adaptive	?	Thermal	Traficon TI-X Stream Edge Control Technologies PIM	N	N	2-Copper	Copper to Enet	
21	Natick	3	West Couplet	Trafficware 980-B140	Y	Y	2	Y	Adaptive	Adaptive	?	Thermal	Traficon TI-X Stream Edge Control Technologies PIM	N	N	2-Copper	Copper to Enet	
22	Natick	3	Shoppers World Drive	Trafficware 980-B140	Y	Y	2	Y	Adaptive	Adaptive	?	Thermal	Traficon TI-X Stream Edge	N	N	2-Copper	Ethernet over copper interface Actelis	
23	Natick	3	Dean Rd/ Mall Rd	Trafficware 980-B140	Y	Y	2	Y	Adaptive	Adaptive	?	Thermal	Traficon TI-X Stream Edge	N	N	1-Copper	Ethernet over copper interface Actelis	
24	Natick	3	U-turn (Golf on the Village Green)	Peek 3000E	N	N			GPS Coord	Free	?	Loop and channel, GPS time reference	Wavetronix, Tassimeo	N	N	-	-	
25	Natick	3	Oak St	Trafficware 980-A2500-1	Y	N	5	Y	TBC	Free	?	Loop	LMD 622t	N	N	Garmin GPS	-	
26	Natick	3	Speen Street at Superior Drive	Siemens 8130-1900-015	Y	N	5	Y	Coord	Free	?					1-Copper		
27	Natick	3	Speen Street at Fire Station	McCain ETC/EX	Y	N	>5	N		Free	?	None	N/A	N	N	3-Copper	-	
28	Natick	3	Speen Street at Hartford Street	Siemens Eagle EPAC 3608 M41	N	N	13	N	Free	Free	?	Video	Iteris Edge 2	N	N	1-Copper	-	
29	Wellesley	6	Overbrook Drive	Trafficware 980-A2500-1	Y	N	<5	Y	TBC	Free	?	Loop	LMD 622t	Y	N	Garmin GPS		
30	Wellesley	6	Kingsbury St and VB U-turn	Trafficware 980-A2500-1	Y	N	5	Y	Free	Free	?	Loop, Thermal	LMD 622t, Traficon TI-X Stream Edge Control Technologies PIM	N	N	1-Fiber	Fiber splice enc. (2) Axis Enet, Axis Siemans Rugged Com	Fiber supports Wellesley PD camera system
31	Wellesley	6	EB U-turn (near Kingsbury St)	Trafficware 980-A2500-1	Y	N	5	Y	Free	Free	?	Loop, Thermal	LMD 622t, Traficon TI-X Stream Edge Control Technologies PIM	Y	N	-	Load switch, FL XFER	
32	Wellesley	6	Connector Rd (Washington St)	Eagle EPAC 3608 M41	N	N	16	N	Free	Free	?	Loop	LMD 622t	N	N	-	Load switch (spare)	
33	Wellesley	6	Oakland St	Siemens 8130-1900-015	Y	N	2	Y	Free	Free	?	Loop	LMD 622t	Y	N	-	Red Signal Ahead relay	
34	Wellesley	6	Sun Life Financial	Trafficware 900	Y	N	<5	Y	Hardwire Coord	Adaptive	N	Loop	N/A	N		1-Copper	-	
35	Wellesley	6	SB 95 Ramps	Trafficware 900	Y	N	4	Y	Hardwire Coord	Adaptive	N	Loop	N/A	N		2-Copper	-	
36	Wellesley	6	NB 95 Ramps	Trafficware 900	Y	N	4	Y	Hardwire Coord	Adaptive	N	Loop	N/A	N		1-Copper	-	
37	Natick	3	Speen Street at Natick Mall Road	EPAC 3608M41	N	?	9	?	Coord	Free	?	Video	Iteris Edge 2	N	N	3-Copper	360 M30, Modem GDI SM3365A	

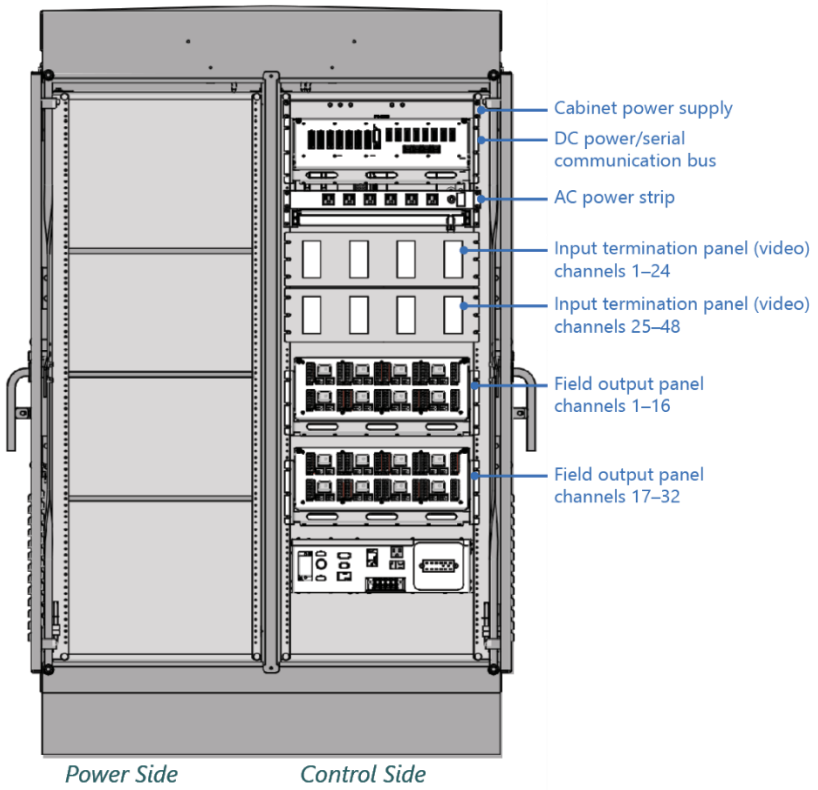
Detailed Infrastructure Design



ATC Cabinet

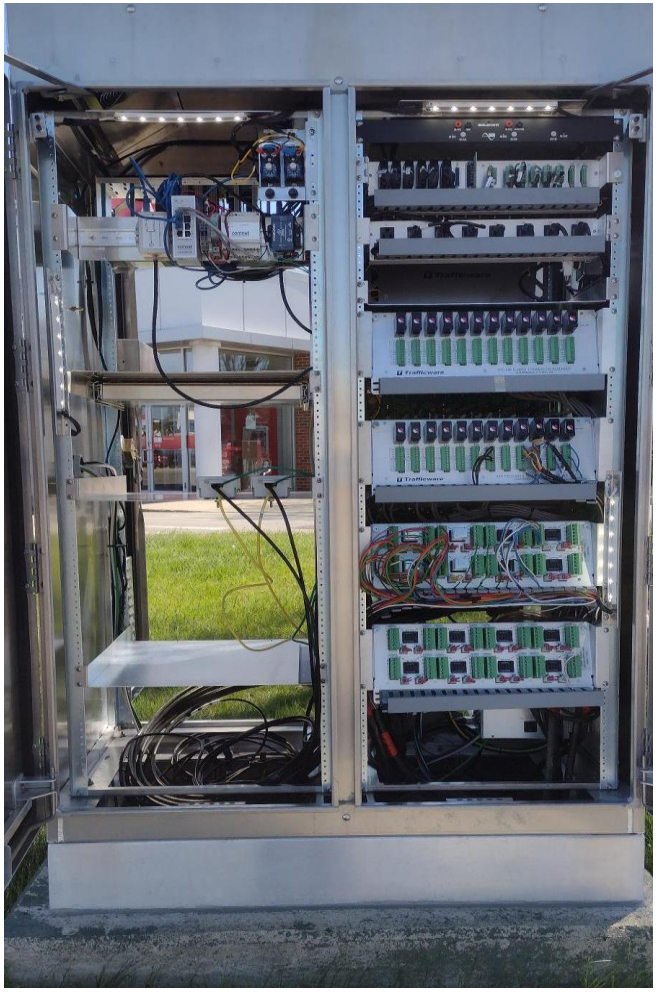


Front View



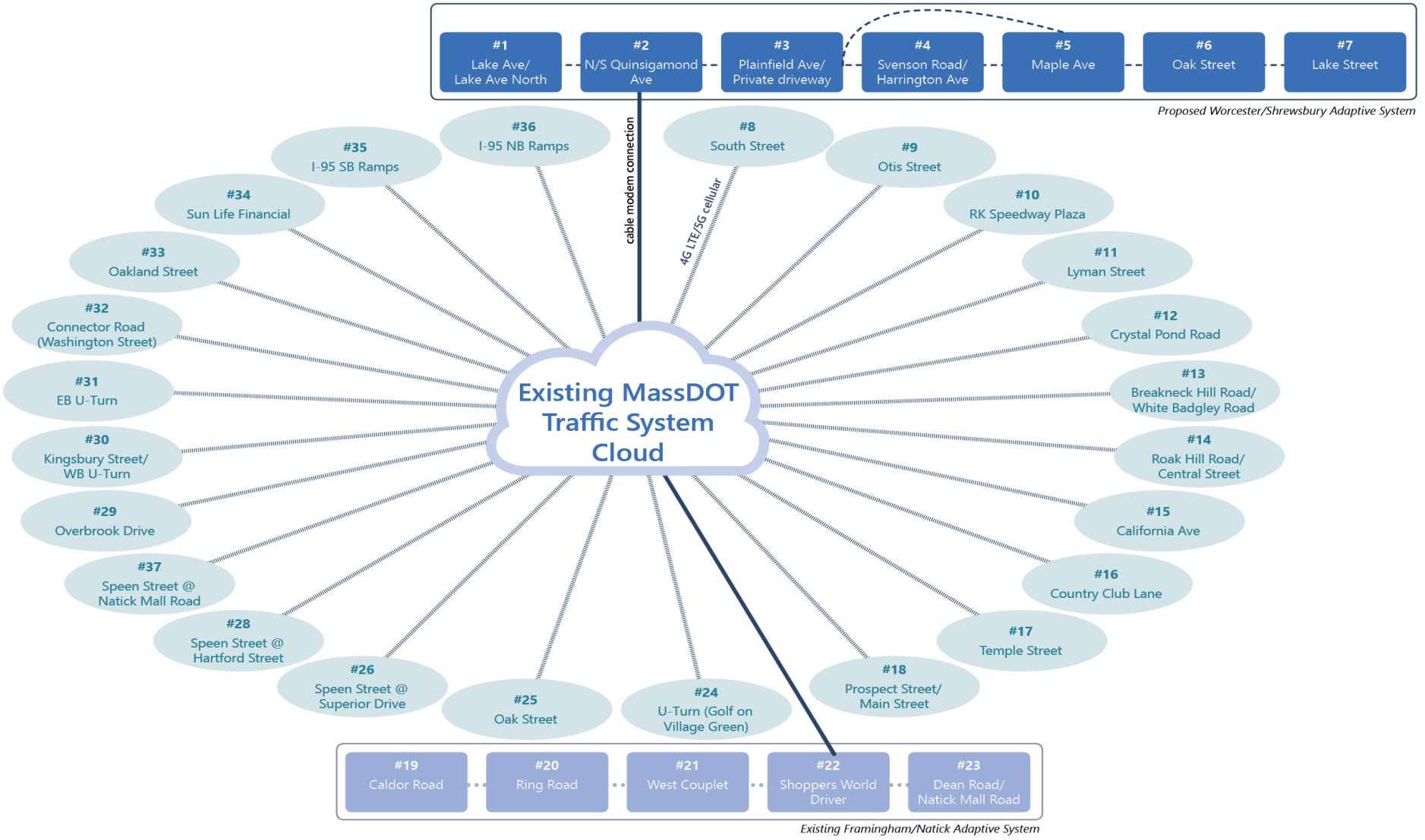
Back View

ATC Cabinet



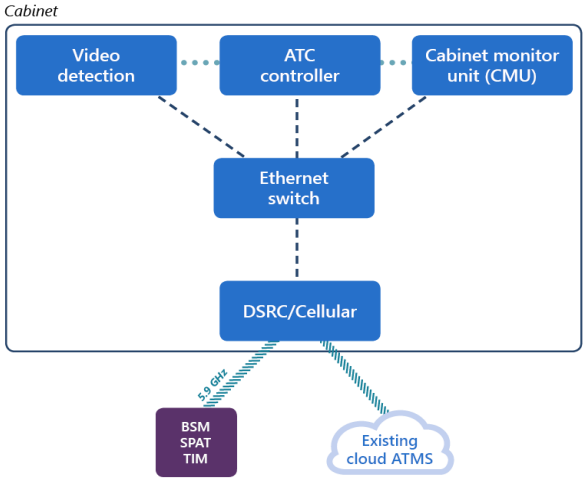
Bench Testing

Central System Architecture

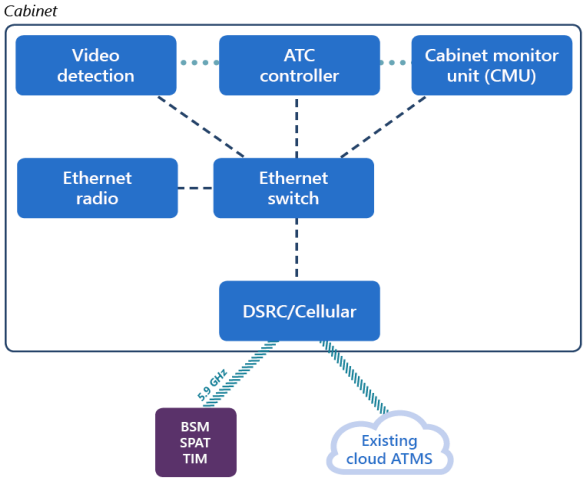


Cabinet Block Diagram

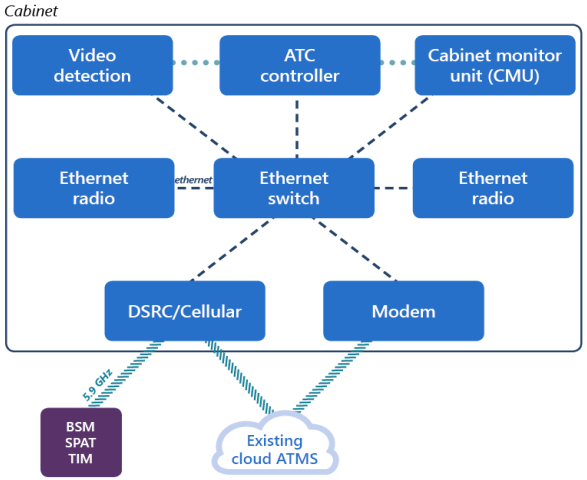
Typical Cabinet—SPaT



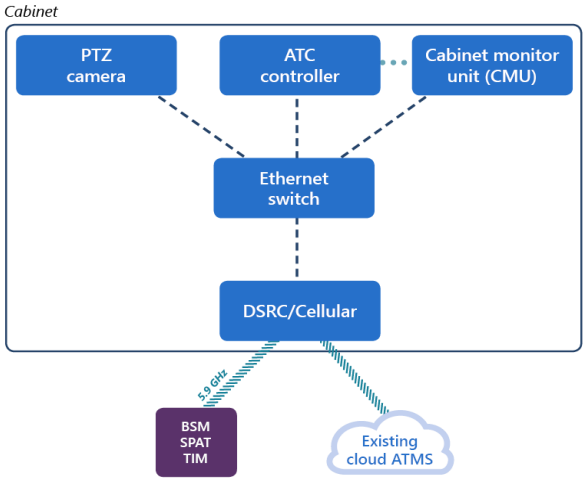
Cabinet—SPaT & Adaptive System | Locations 1, 7, 19, 23



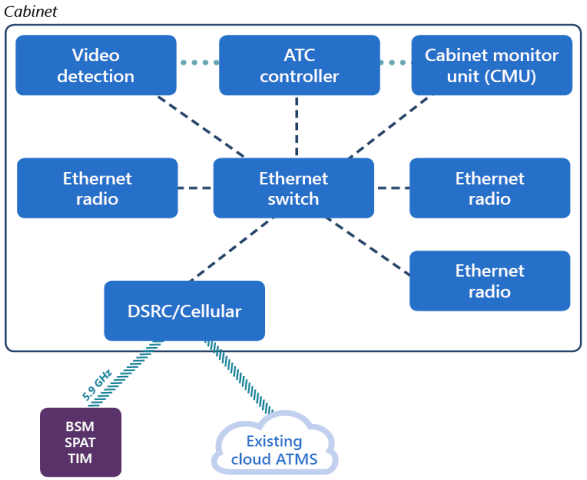
Cabinet—SPaT & Adaptive System | Locations 2, 22



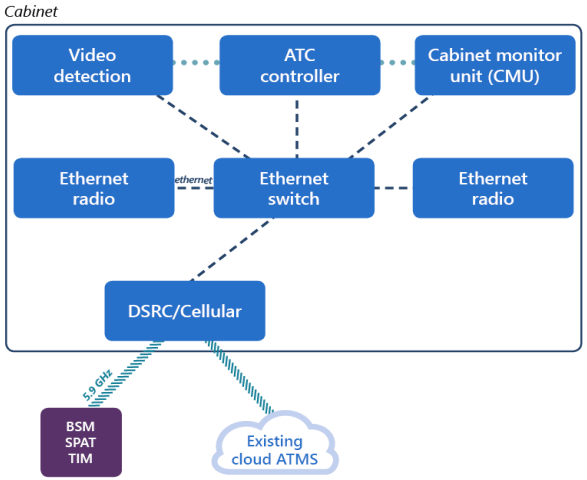
Cabinet—SPaT & Adaptive System | Locations 11, 34, 35, 36



Cabinet—SPaT & Adaptive System | Location 3



Cabinet—SPaT & Adaptive System | Locations 4, 5, 6, 20, 21



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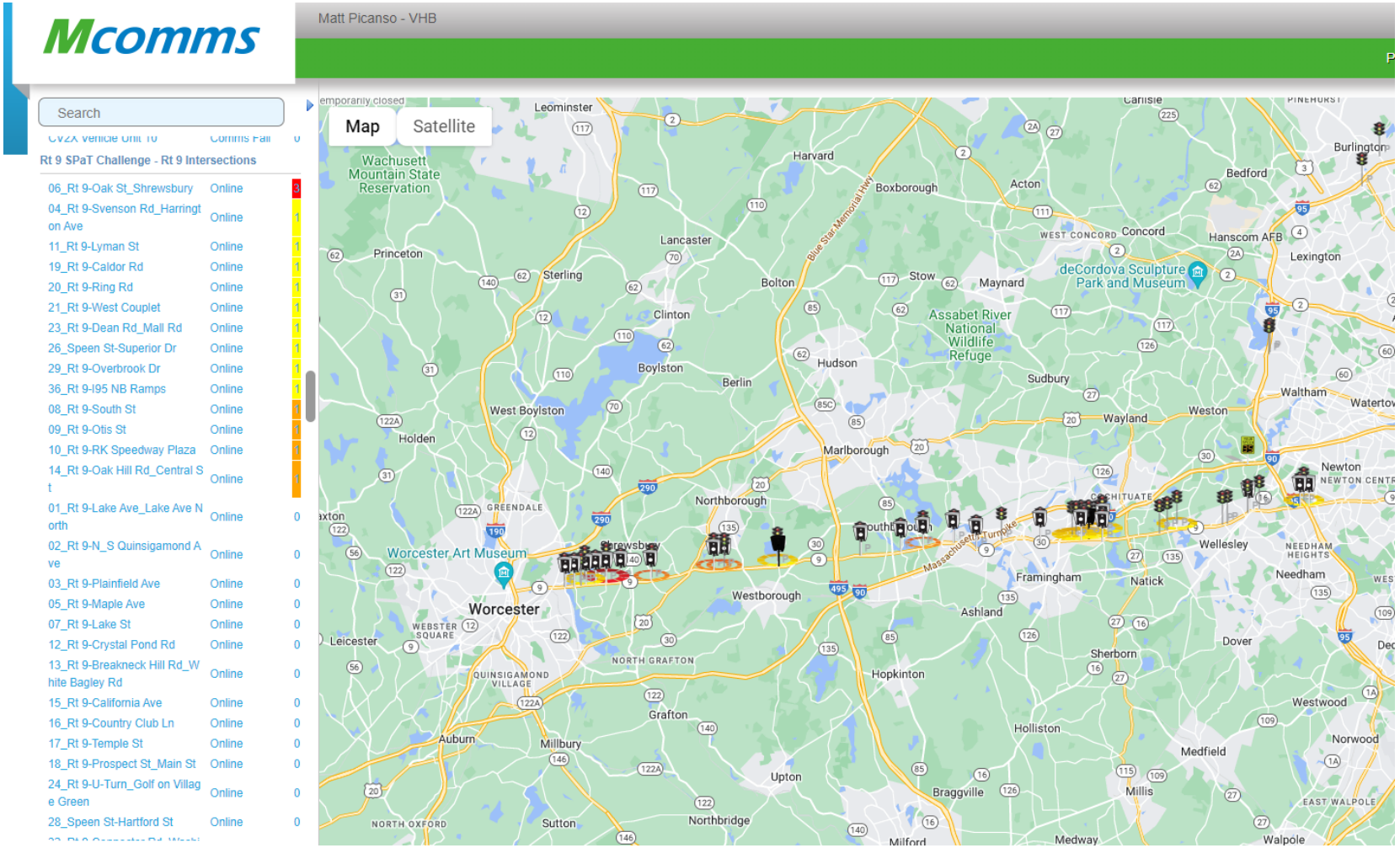
MassDOT Cloud System



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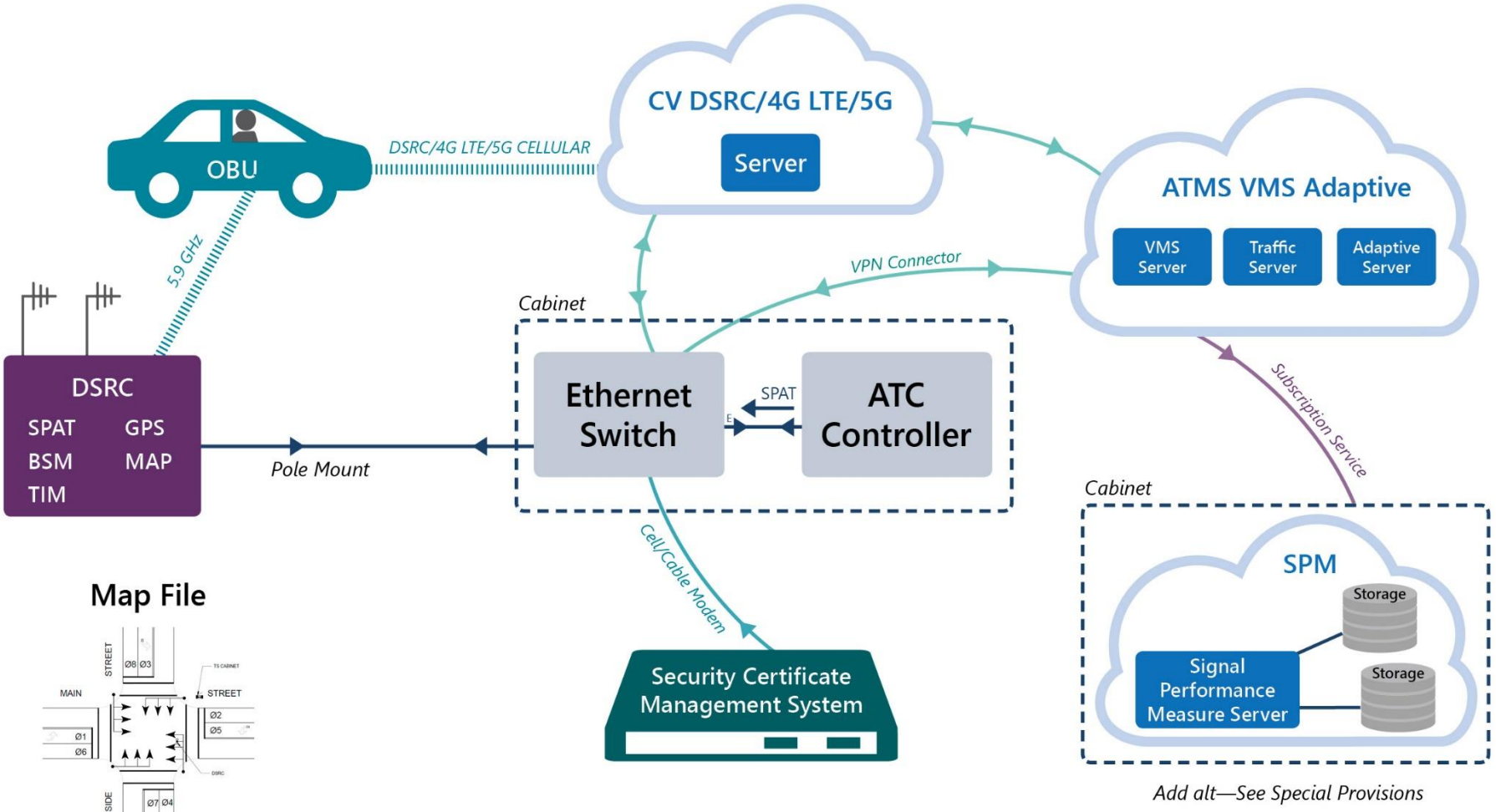
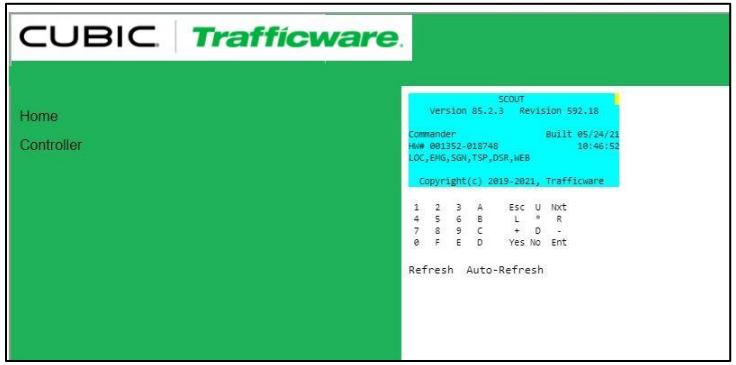
Network Flow Diagram



Field Monitoring Unit (FMU)

FMU Functions:

- Remote Front Panel to Controller
- Remote video access
- Cabinet Telemetry



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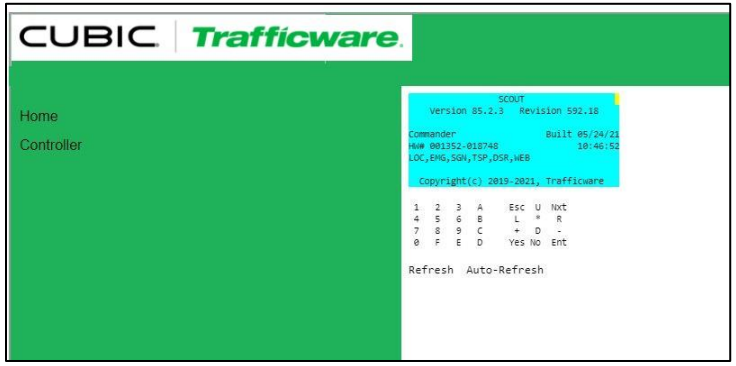

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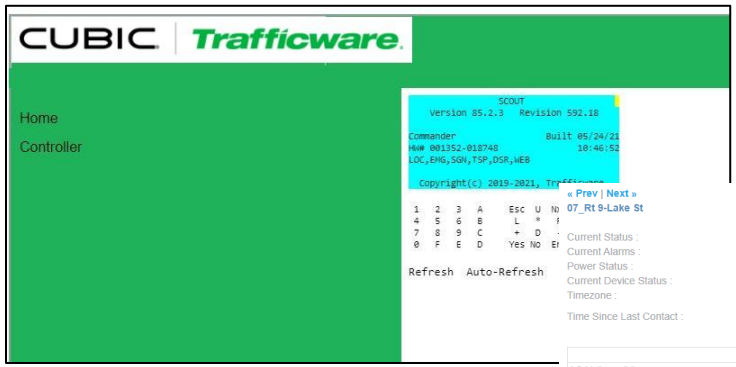

« Prev | Next »
07_Rt 9-Lake St

[Refresh]
[Trafficware]

Current Status :	Online
Current Alarms :	
Power Status :	OK
Current Device Status :	OK
Timezone :	-4 Hours
Time Since Last Contact :	12 Minutes 36 Seconds 5/9/2022 8:34:19 AM

	Now	Min	Max	Avg
AC Voltage (V)	125.5	124.2	125.9	125.1
Cabinet Temp (F)	68	57	88	71
Humidity (%)	21.7	9.3	28.1	18.6
Monitor Batt (V)	13.5	13.5	13.5	13.5
Block Counter	0	0	0	0
Lockout Counter	0	0	0	0
Data Rate	0	0	0	0
095 System Voltage (V DC)	22.5	22.4	22.6	22.5
095 Battery Voltage (V DC)	14.2	14.2	14.2	14.2
095 Temperature (F)	77	65	82	73

	Status
Cabinet Flash	OK
Stop Time	OK
Door Status	Closed
Outlet Power	On
Preempt Status	None
Preempt Active	None
Cabinet Fan	Fan OFF
Network Status	All Good
Controller Status	All Good
C-V2X Status	GOOD
DSRC Status	DISABLED
095 Door Status	Closed
095 KDS	Ok
095 Health	Good

	Status	
Outlet Power		On
Output		

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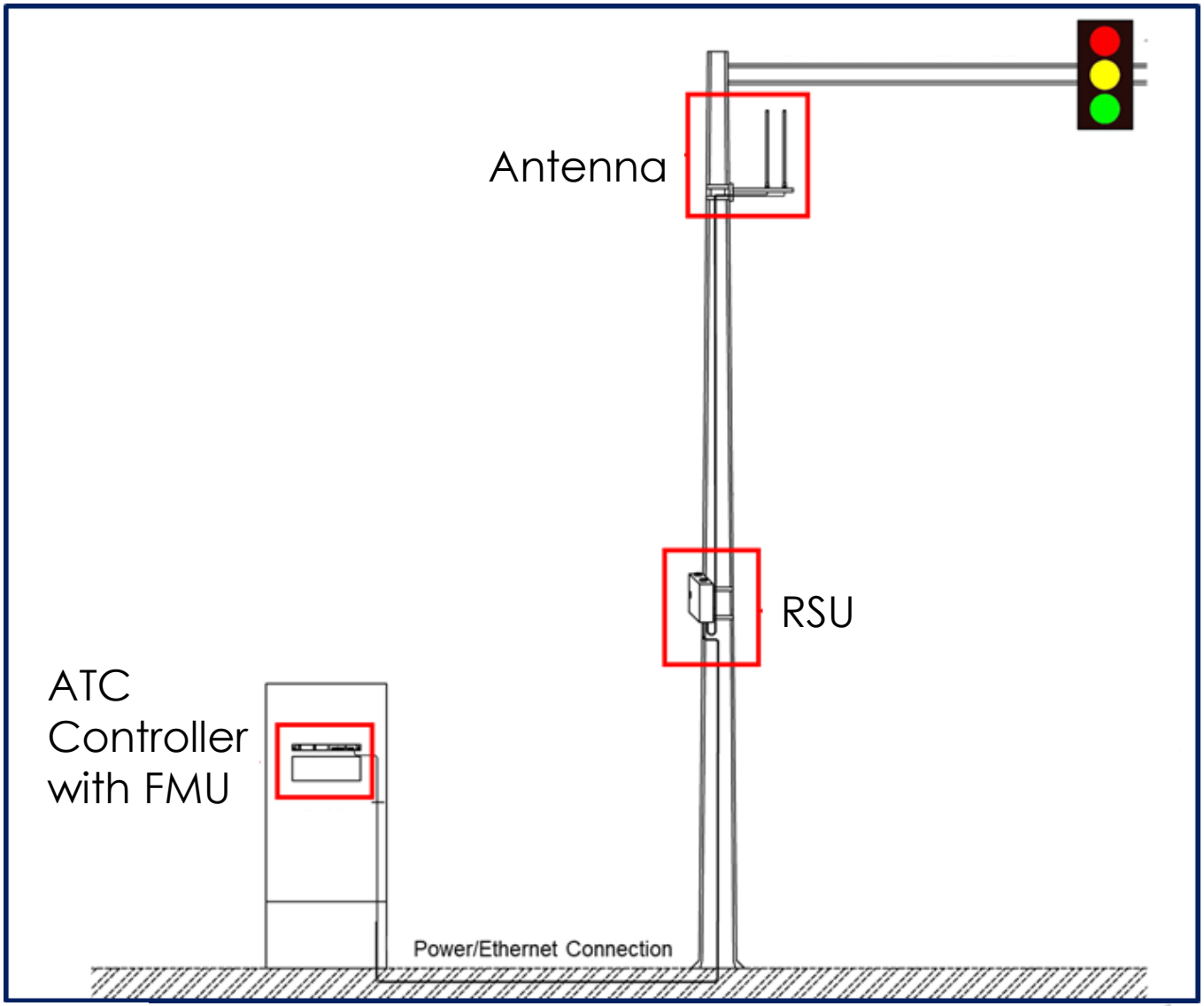
RoadSide Unit (RSU)

RoadSide Unit (RSU)

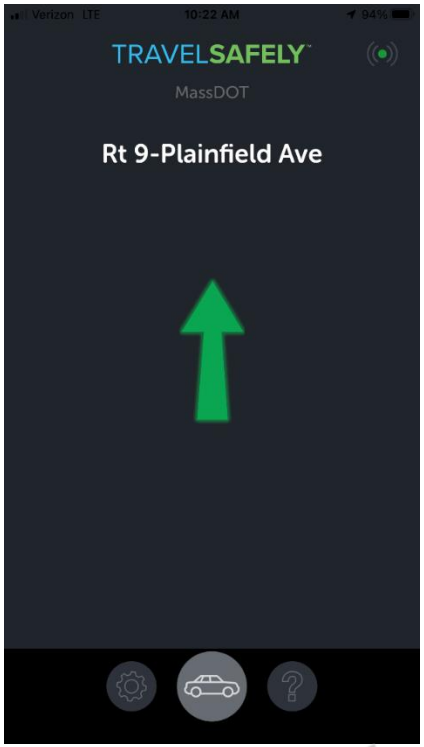


RoadSide Unit (RSU)

On Board Unit (OBU)

- OBU
  - C-V2X/DSRC/5G Support
  - Pre-emption/Priority
  - TSP
  - Full CV application Support

- Mobile App
  - 4G-Lte Support
  - SPaT
  - Basic Safety Message (BSM)
  - Traveler Information Message(TIM)



Route 9 SPaT Demonstration Video

Current Status and Next Steps

- Construction Started in 2021
- All ATC/ATCC/Detection equipment installed
- All on street CV equipment installed
- Fine tuning of the cloud-based systems
  - Adaptive
  - SPM
  - Geo Fencing for C-V2X
- Acceptance Testing
- O & M
- Public Outreach

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Phase II

- Initiated stakeholder engagements
  - Ongoing meetings with stakeholders along the corridor
  - Primary focus on Transit and Freight Operators
  - Secondary focus on Auto Manufacturers
- Determine and Implement Uses of the SPaT Infrastructure System
  - Applications which support driver needs
  - Handheld devices which support pedestrian needs
- Examine USDOT/FHWA Grant Opportunities to expand and fund the system through out New England

Partnership Opportunities

Transit Operators

MetroWest Regional Transit Authority (MWRTA), Worcester Regional Transit Authority, Logan Express

WRTA
Worcester Regional Transit Authority

Freight Carriers

US Postal Service, FedEx, UPS

FedEx
UNITED STATES POSTAL SERVICE
ups

Ride Share:
Uber/Lyft

Uber
lyft

Auto Manufacturers

Audi, Nissan, Cadillac, Toyota, Lexus

ITS-NY
Intelligent Transportation Society of New York

massDOT
Massachusetts Department of Transportation

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Future V2X Applications

Vehicle Based Applications that Utilize SPaT

- Red Light Violation Warning (RLVW)
- Pedestrian in Signalized Crosswalk Warning
- Eco A/D (aka Traffic Optimization for Signalized Corridors (TOSCo))

Personal Device Based Applications that Utilize SPaT

- Mobile Accessible Pedestrian Signal System (PED-SIG)

Other V2I CV Applications

- Signal Priority (transit, freight, other fleet vehicles)
- Emergency Vehicle Preemption (PREEMPT)
- Probe-enabled Traffic Monitoring

Questions?

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