# New England ITS

## DSRC Deployment for Early Adopters

### April, 2019

# Agenda - Summary

- Brief Introduction
  - *DSRC*
  - *Key Message-Types*
  - *C-V2X*
  - *State of Market*
- Key Deployment Strategies
  - *Processes*
  - *Recommendations*
- Wrap-up

# Introduction

*Wading into the pool…*

# CV Overview and Background

Vehicles, infrastructure, and/or mobile devices broadcast messages via wireless communications media

These messages are received by other vehicles, infrastructure, and mobile devices to enable CV *applications*

An application is a collection of physical objects, functional objects, and communications that are tailored to fit a real-world transportation problem or need



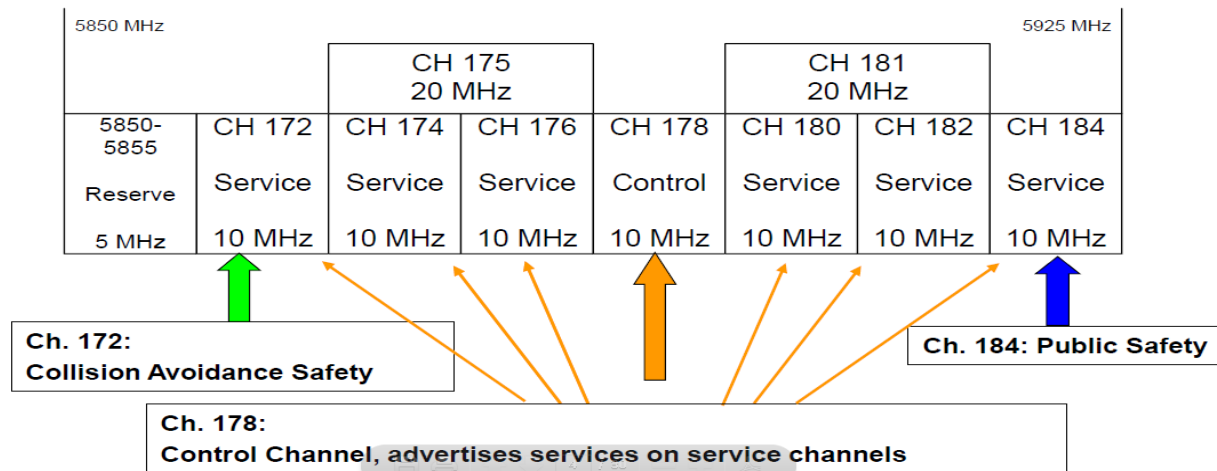This should not be the outcome of "any" Connected Vehicle Deployment…

# Technology Overview (Geek 101)

## Direct Short Range Communications (DSRC)

- 5.9 GHZ FCC licensed spectrum
- High –Bandwidth/Low Latency
- Broadcast mode – 1800M Maximum - LOS
- Engineered to work in a moving vehicle
- Secure and Reliable

## Cellular/Mobile Network

- Privately deployed, multi-use infrastructure
- Higher relative latency and lower bandwidth
- Suitable today for most non-safety critical applications
- Largely supported by the telecom sector
- Reliant on subscription service



| 5850 MHz | | CH 175 20 MHz | | | CH 181 20 MHz | | 5925 MHz |
|---|---|---|---|---|---|---|---|
| 5850-5855 | CH 172 | CH 174 | CH 176 | CH 178 | CH 180 | CH 182 | CH 184 |
| Reserve | Service | Service | Service | Control | Service | Service | Service |
| 5 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz | 10 MHz |

Ch. 172: Collision Avoidance Safety

Ch. 184: Public Safety

Ch. 178: Control Channel, advertises services on service channels

# CV Terminology

**Basic Safety Message (BSM)**

Standard message broadcast from vehicles which includes information on location, speed, heading, acceleration and other parameters
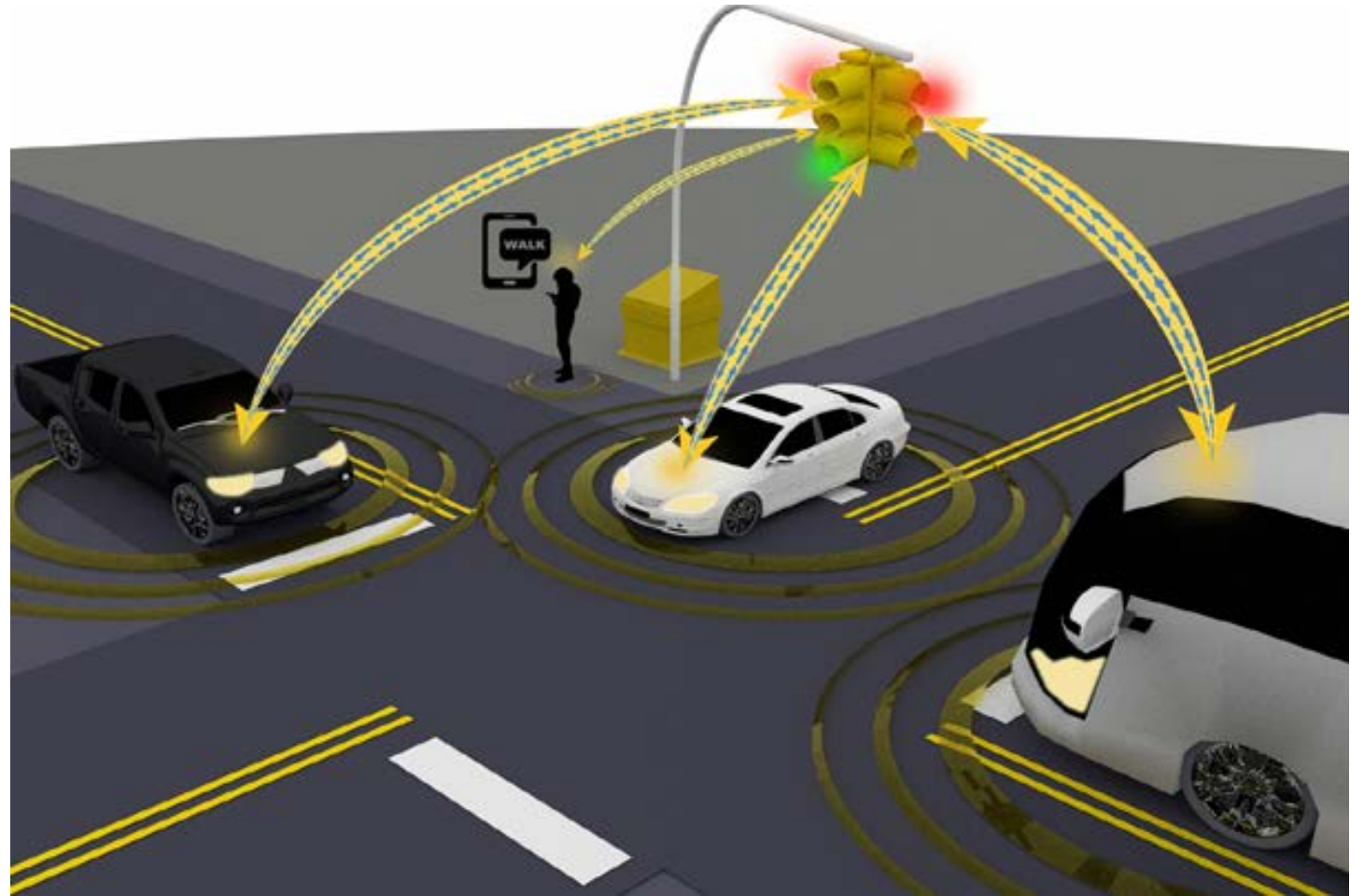


Source: U.S. DOT

WSP

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# CV Terminology

**Signal Phase and Timing (SPaT)**

An infrastructure-based message using direct controller output which provides information about the current signal phase being served, time until phase termination, and other parameters.

# CV Terminology

**Traveler Information Message (TIM)**

Configurable message transmitted from infrastructure to vehicles

which can include a range of information about roadside features, geometric configuration, and warning information (note: will be replaced by the Basic Infrastructure Message (BIM) –standard under development). Several flavors include: Weather, Curve Speed, Vehicle-Driver Alerts.

# CV Terminology

**Personal Safety Message (PSM)**

A message transmitted from personal mobile devices to a vehicle or to infrastructure which contains safety data regarding the kinematic state of various types of Vulnerable Road Users (VRU) (This message is under development)
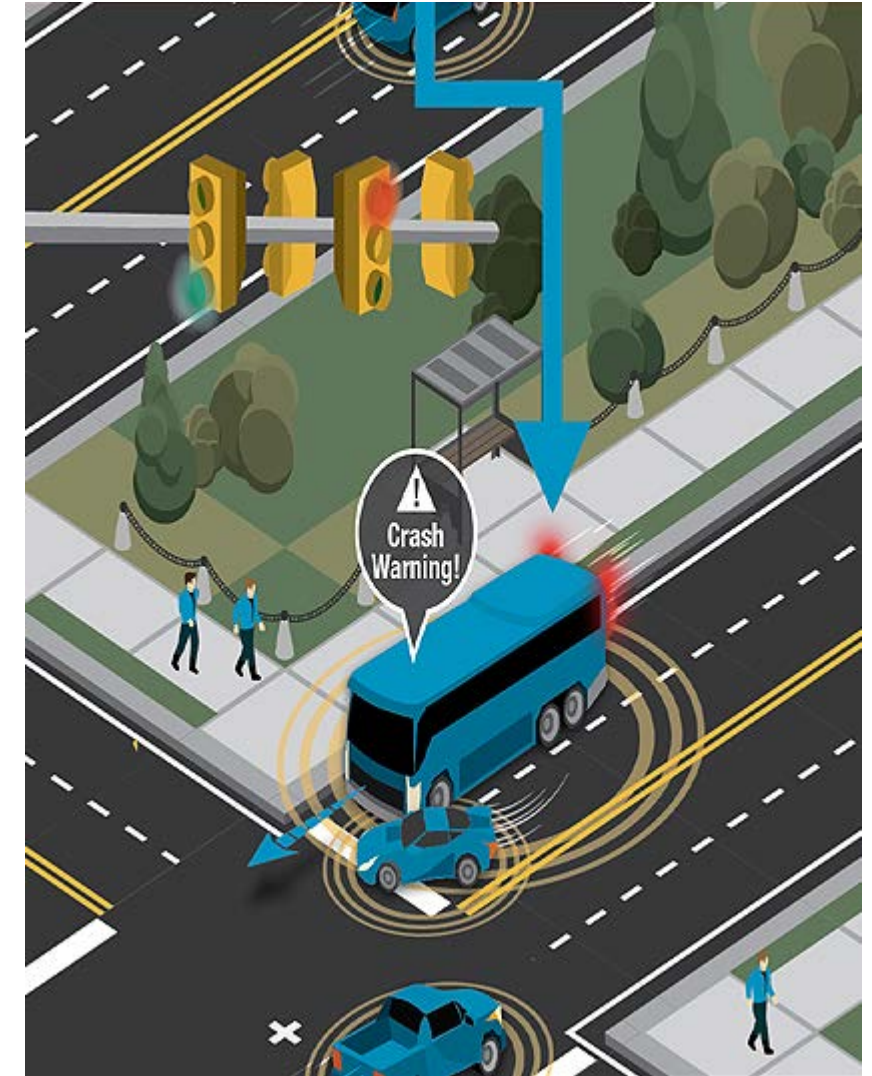
# Vehicle-to-Vehicle (V2V)

Application supported through communications between two vehicles

Examples:

— *V2V Basic Safety*
  — Emergency Electronic Brake Lights, Forward Crash Warning, Intersection Movement Assist, etc.
— *V2V Special Vehicle Alert (Emergency Vehicle)*
— *Transit Vehicle at Station/Stop Warning*
— *Vehicle Turning Right in Front of a Transit Vehicle\**
— *End of Queue or Emergency Brake Light*



Crash Warning!

WSP
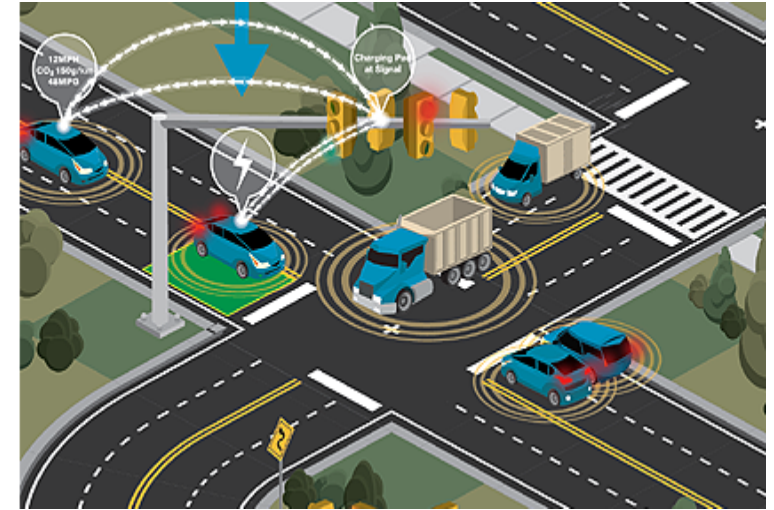
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# Vehicle-to-Infrastructure (V2I)

Application supported through communications between vehicles and infrastructure

Examples:

— *Intersection Safety Warning and Collision Avoidance (S)*

— *Reduced Speed Zone Warning (S)*

— *Transit Pedestrian Indication (S)*

— *Transit/Freight Signal Priority (M)*

— *Emergency Vehicle Preemption (M)*

— *Winter Maintenance\**





https://www.its.dot.gov/infographs/mdss.htm
https://www.its.dot.gov/infographs/Eco_traffic_signal_timing.htm

# Vehicle-to-Infrastructure (V2I) – Vehicle Data for Traffic Operations

Probe data obtained from vehicles to support traffic management

- *Local, real-time data and performance measures*
- *Supports implementation of operational strategies.*

Provides access to information from large vehicle population as penetration of CV technology increases.



https://www.its.dot.gov/infographs/data_capture.htm

# Pedestrian-to-Everything (P2X)

Application supported through communications between VRU mobile devices and vehicles or mobile devices and infrastructure

Current USDOT research in this field
— *Mobile Device user safety*
— *Enabling mobility as a service applications*

Examples:
— *Pedestrian in Signalized Crosswalk (S)*
— *Transit Vehicle at Station/Stop Warning (S)*
— *Pedestrian Intersection Mobility (M)*
— *Transit Traveler Information (M)*

# Example Business Cases for DSRC

— Consumable/available now
  — *Heavily tested (more "must" come through lifecycle")*
  — *Certifications via OmniAir "coming online" (need improvements)*
  — *Specifications and Agency/Application Testing are key to uses*

— Low Latency

— Improve Safety

— Reduce Congestion, Clearance Times and "event detection"

— Reduce crash severity and potentially save lives

— Rich set of big data and analysis "tools/logic"
  — *TSMO improvements*
  — *Signal and Corridor Optimization*
  — *Incident-Event Management (broader detection)*
  — *Exposure, deployment, use, performance measures = next iterations*

# Technology Comparison

*"Ehh - What's up doc"…*

# Industry Summary – a tale of two technologies...

VHS vs. Betamax

Car vs. Horse

Or today on the vehicle-side (DSRC or CV2-X)

Government position

— *Heidi King, deputy administrator at the National Highway Traffic Safety Administration, said the Department of Transportation was "technology neutral" on communication protocols.*

https://www.nhtsa.gov/speeches-presentations/keynote-address-its-america

1900 – Easter Morning 5th Avenue, NY

1913 – Easter Morning 5th Avenue, NY – Find a horse...

# Industry Summary (cont.)

- DSRC – "wireless derivative"
  - *DSRC testing over 20+ years*
  - *Crash Avoidance Metrics Partnership (CAMP) backing/testing*
  - *Multiple Agencies with substantial deployments "ongoing"*
  - *2017 US/Japan*
  - *2019 European production ramp starting-up*

- C-V2X – "cellular derivative"
  - *C-V2X technology was introduced recently*
  - *C-V2X is defined by 3GPP based on cellular modem technology*
  - *Different non-interoperable access layer to DSRC*
  - *C-V2X is maybe gaining steam in other regions.*

# C-V2X things you should know…

Vocabulary difference between CV-X (DSRC) and C-V2X (Cellular) and V2X (Vehicle to Everything)

— *Industry pressure on 5.9 GHz spectrum/bands (DSRC)*
— *Industry pressure to commit "future-proof" viewpoint (e.g. cellular solution)*
- Cellular needs more long-term/larger testing scenarios
- More companies/industry mix joining 5-GAA

Device-to-device [1] mode (V2V, V2I, V2P) operation

— *C-V2X does not necessarily require any network infrastructure.*
— *Can operate without a SIM and without network assistance*
— *Uses GNSS as it's primary source of time synchronization*
— *Supports V2N applications using existing cell network with voice/data*
— *V2N would require Mobile Network Operator (MNO) for commercial services and network assistance*

[1] Relies on the PC5 interface specified by 3GPP for device-to-device operation.
[2] See 3GPP TR 22.885 Study on LTE Support for Vehicle to Everything (V2X) Services.

# Key Deployment Strategies

*Not your average VEE...*

# Leverage a quicker/quality process (Agile)

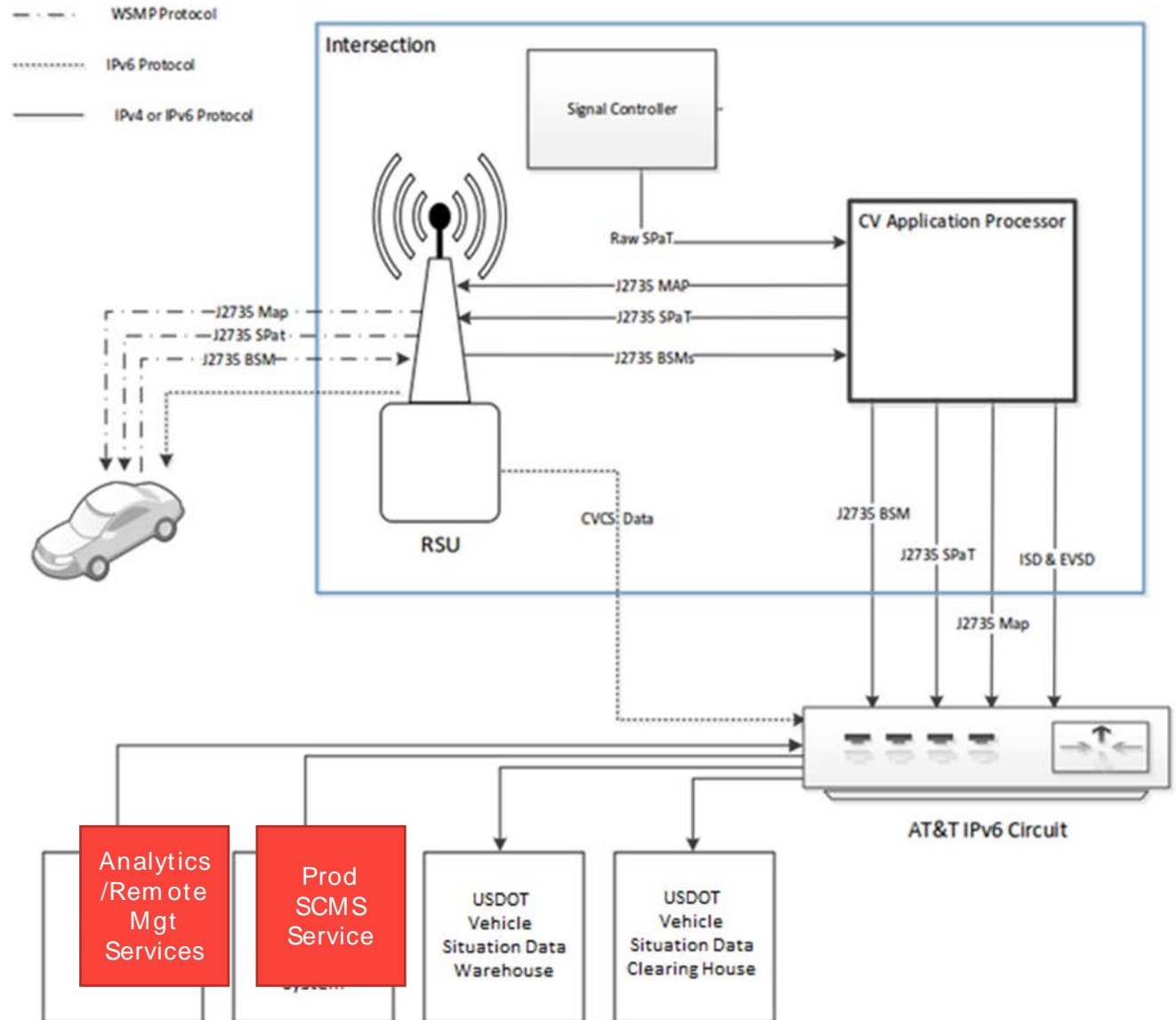As a market we should begin moving from VEE to Agile...
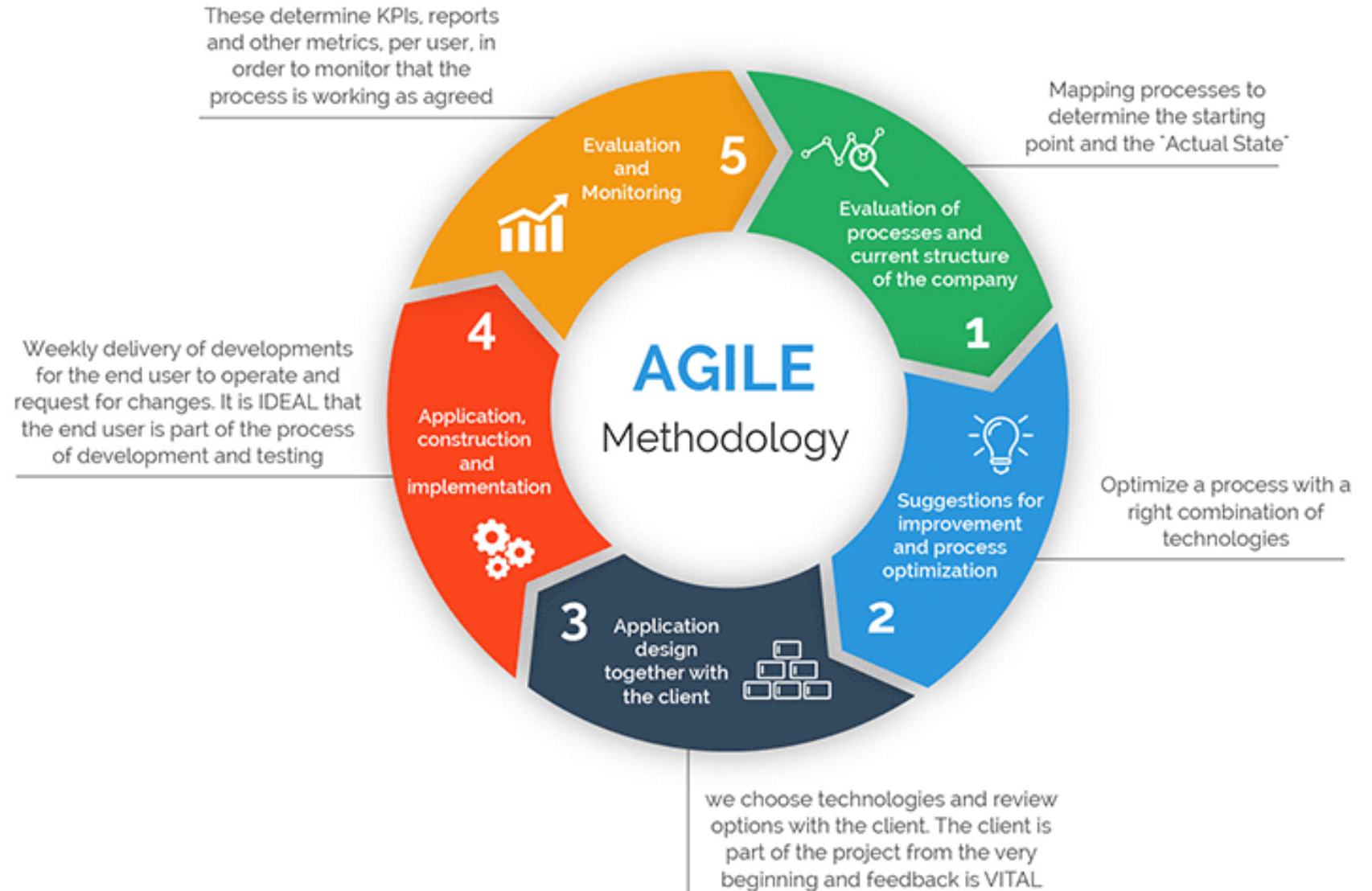
# Connected Corridor Overview – Envisioned Applications

**Work the process...**

**Vehicle Data for Traffic Management**

- *BSMs and other vehicle-based messages captured by roadside CV equipment*
- *Data from roadside equipment (e.g. signal controller) also captured*
- *Supports traffic management activities*

# High-level Requirements (Network)

- Develop/design network architecture and CV topology
  - *Design and develop IP addressing plan/VLAN*
  - *Management strategy for IP6/IP4 overlay implementation*
- Provide native connectivity IPv6 end to end
  - *Tunnel is an option, not really scalable/cost effective*
- Provide separate IPv6 network traffic from Core
- Provide separate IPv6 network traffic to Internet
- Provide secondary ISP connection
  - *Avg. 5 Mbps per month; per RSU*
  - *Configuration parameters vary bandwidth needs*

# High-level Requirements (Network)

— **Provide dual**-stack cabinet switches (IPv4/IPv6) with VLAN support

— Provide separate high-end router

— Provide separate high-end firewall with inspection

— Provide integration support for VLANs through network

— Provide O&M of equipment through lifecycle

— Provide configuration and integration support of equipment

# Security – Security and please focus on security...

— Safety critical applications regardless of DSRC, C-V2X (or 5G)

- — *Ability to revoke certificates via CRL*
  - — Bad Actors
  - — Rogue Devices
  - — Misbehavior
- — *Messages + Devices require secure method that is scalable for*
  - — Verification
  - — Validation
  - — Authentication
- — *Production Commercial SCMS certificates*
  - — Provider Service ID by message-set type
- — *Introduce new attack surfaces and threat vectors*
- — *Start needs to be foundation across lifecycle*
  - — Planning, Design, Configuration/Testing, Deployment and O&M

# High-level Requirements (RSU/OBU)

- IPv6 address for each management interface
  - *IPv6 addressing on RSU's and DSRC radios*
  - *Separate address ranges are required*
  - *Ideally segment network and range use*
- Provide dual DSRC radios with channel switching per RSE
- Provide a minimum 300m DSRC coverage/avg. 1500 m DSRC coverage
- Provide device that functions and interoperates
  - *(USDOT 4.1 RSU Specifications or above)*
  - *OmniAir Certification,*
  - *USDOT SCMS National Architecture conformance*
  - *Above changes a number of function, feature & architecture = custom spec.*
- Develop channelization plan for RSU's
- Integrate and Test (bench, mock-up, field examples)
  - *Equipment planning to procure and deploy*
  - *Develop and implement use cases – test cases*
  - *Validate data and metrics*

Sample Site Plan - Radio Coverages & Channels

Safety Pilot Project Area

Device Sites & Service Channel Assignments
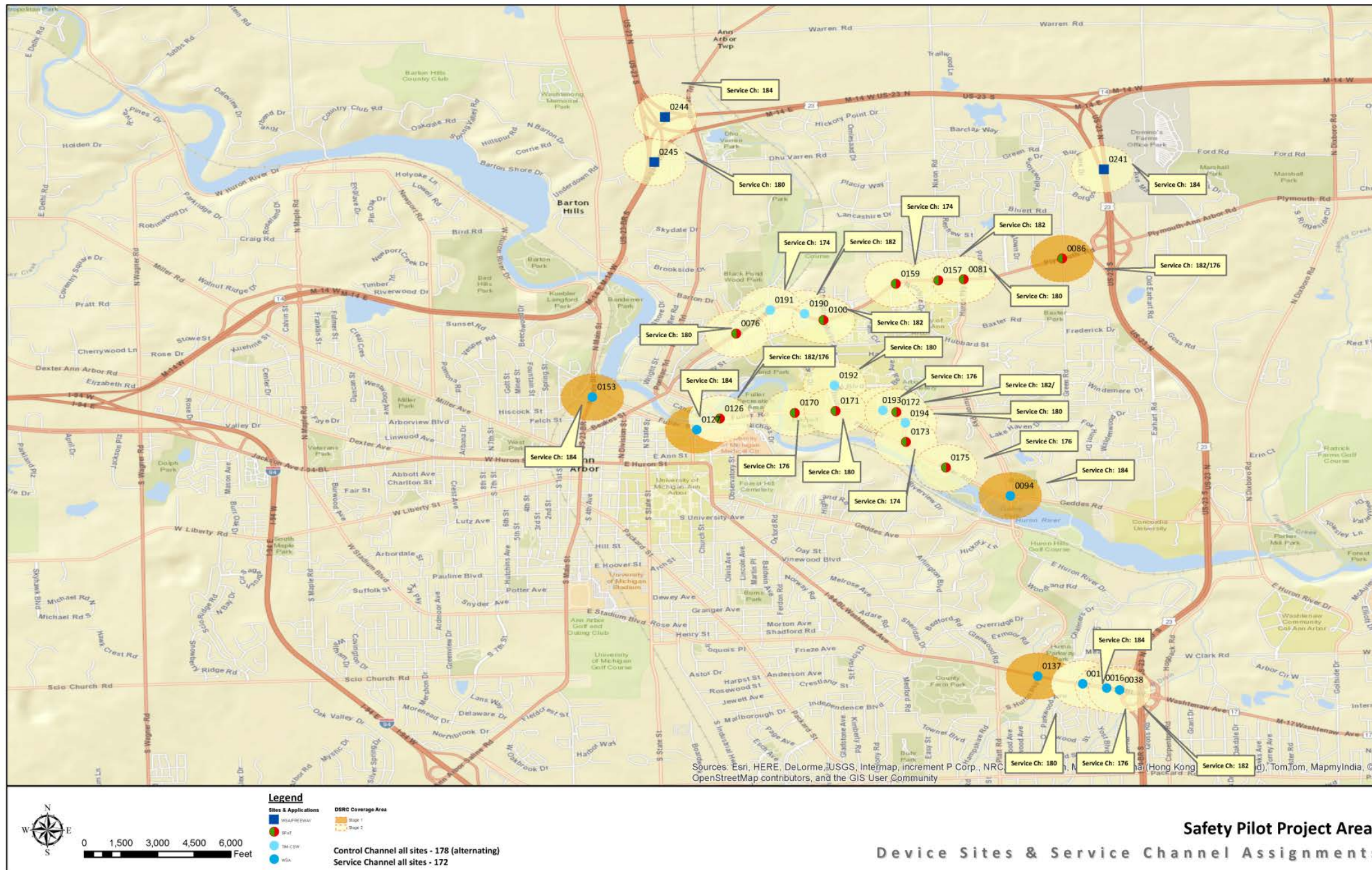
# Wrap-up

*Almost there...*

# 01- Deployment Strategy (Early)

— **Make new friends** – ID Stakeholders
  — *CAV Workgroup – might work for certain Agencies*
— Define Needs, Requirements, ConOp, Metrics
  — *SAE J2735 Message/Application Priority Definitions*
— Define how and who gets to handle - IP6 methodology
  — *IP4/IP6 dual stack\**
  — *Native IP6\**
  — *Secondary ISP\**
  — *IP6 just on edge (risk)*
  — *IP6 tunneled on IP4 (risk/cost)*
— Define Network Design/Architecture
— Finalize Sites, Quantities & Equipment
— Prep Cost Estimates & Specifications
  — *ID and Evaluate Specific Add-in Requirements*
— ID Risk & Risk Mitigation

# 02-Deployment Strategy

- Perform Field Work/Evaluation/Comm Paths
  - *Apply "General/Region" FCC license grant for DSRC*
  - *Update "license" by site/device after deployment*
- Develop RFP/Release
  - *Prepare and Perform Bench Testing (90d)*
  - *Finalize Ranking*
  - *Procure Equipment*
  - *Network, ISP and Security all have to get through design "together"*
- Messages Prep (TIM/MAP) – High resolution LIDAR data collection/post-processing
- Testing
  - *Prepare and Perform Interoperability and Mock-up Testing (60d)*
  - *Prep/Configure by Site on Bench*
  - *Field Roll-out by Corridor*
  - *Field Test per site*
- Update FCC licenses – site by site (heights, final positions, etc.)
- Finalize Go-Live/Production Cut-over

# Summary

- Standards, Specs, Licenses, Security are key drivers to function (IEEE 1609.x, SAE J27x, IEEE 802.x, FCC, SCMS)
  - *Frequency and spectrum (analysis/interference)*
  - *Not all the suppliers are interoperable/functional per spec.*
  - *None of these are traditional ITS device/suppliers*
- Plan, Design, Execute, Test, Implement, Operate, Evaluate, Revise
  - *Process & Documentation*
- Working together to break down silos for stakeholders and within/across Agency deployers
  - *Traffic, Signals, Maintenance & IT – "happy family"*
- Testing, Evaluation and Revision Processes are key fundaments
  - *Train folks involved (focus on effective troubleshooting)*
  - *Cut across technologies/silos*
- A parting shot over the bow…
  - *As an industry we need to move past VEE to Agile methods*