DSRC in Tennessee

TDOT Deployment Guidelines

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Outline

1. Background
2. History
3. Current Activities
4. Next Steps

What is DSRC?

This?

- Defense Supercomputing Resource Center (US DoD)
- Dunnings Squash & Racketball Club (UK)
- Darnestown Swim & Racquet Club(Maryland)
- David Sarnoff Radio Club (a ham radio club)
- David Skaggs Research Center (Boulder, CO)
- Disability Services Resource Center (Michigan)
- Data Software Research Company (Chennai, India)
- Duke Surgery Research Central (web application; Duke University; North Carolina)

What is DSRC?

Or better yet, this?

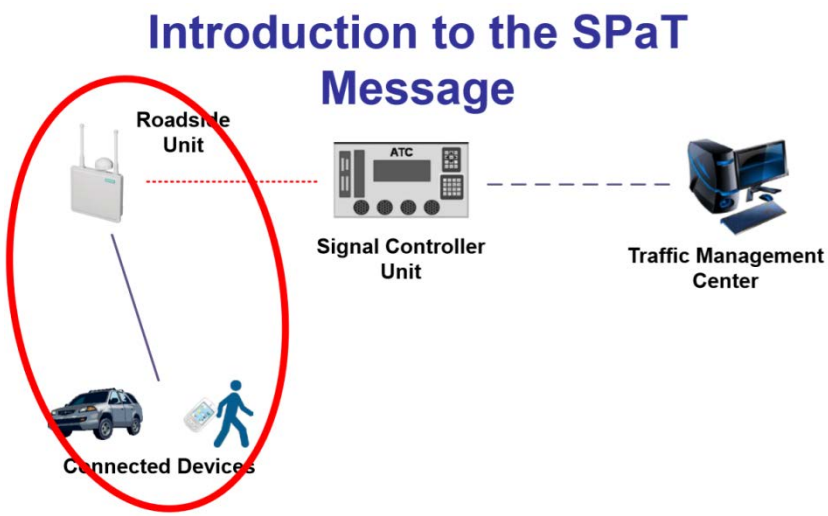
- Dead Serious Rock Concert (for Deadheads only)
- Downtown Scooter Reconditioning Center (Lime, Bird, Uber, Lyft)
- Dermatologists Sacrificing Rare Carrots (Radical Vegan Skin Doctors)
- Detoxified Salad Restaurateurs and Caterers
- Disappointing Sauce Reimbursement Center
- Difficult Salespeople Recording Conversations
- Disco Seventies Retro Car

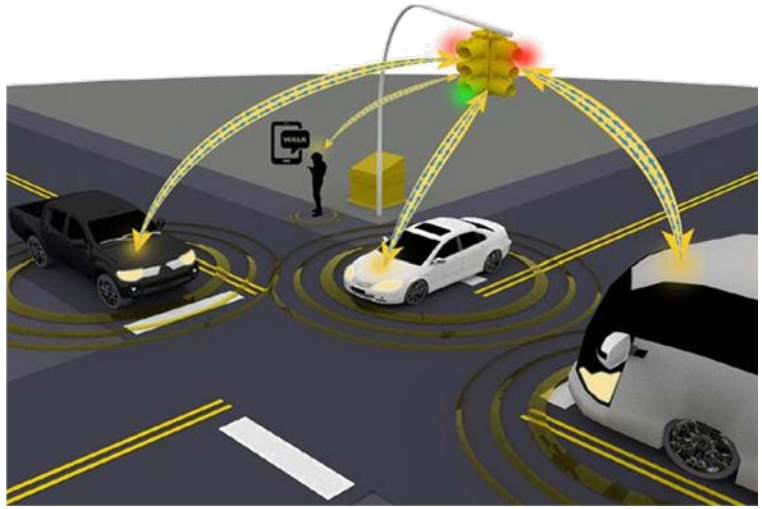
What is DSRC?

- **Dedicated short-range communications** are one-way or two-way short-range to medium-range wireless communication channels specifically designed for automotive use and a corresponding set of protocols and standards.
  - In 2004, the FCC dedicated 75 MHz of bandwidth at 5.9 GHz to be used for vehicle safety and other mobility applications. DSRC operates in this band, and has been developed for over a decade by a range of stakeholders including automakers, electronics manufacturers, state highway departments, and the federal government.
  - Low Latency & Limited interference: DSRC latency is as low as 0.02 second. DSRC is very robust in terms of radio interference with a range of 1000 meters (3281ft).
  - The intent of DSRC broadcast of a suite of message sets (SPaT, MAP, BSM, RLW, etc) at 5.9 GHz is to provide secure transmissions of the data with short time delays during all weather conditions

SPaT – Signal Phase and Timing

- Common Message Set delivered via DSRC



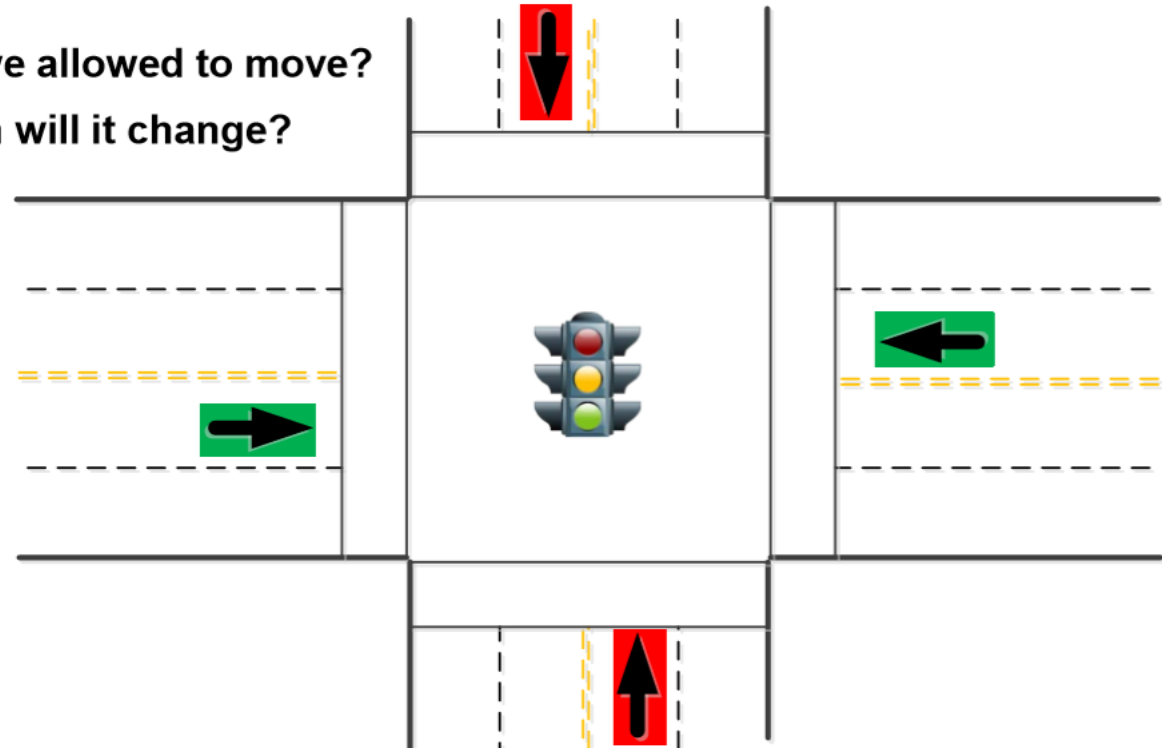


- SAE J2735 – DSRC Message Set Dictionary
  - Current version: SAE J2735_201603
  - Developed with international community input

J 2735 SPaT Message

Data Frame: MovementState

- Are we allowed to move?
- When will it change?



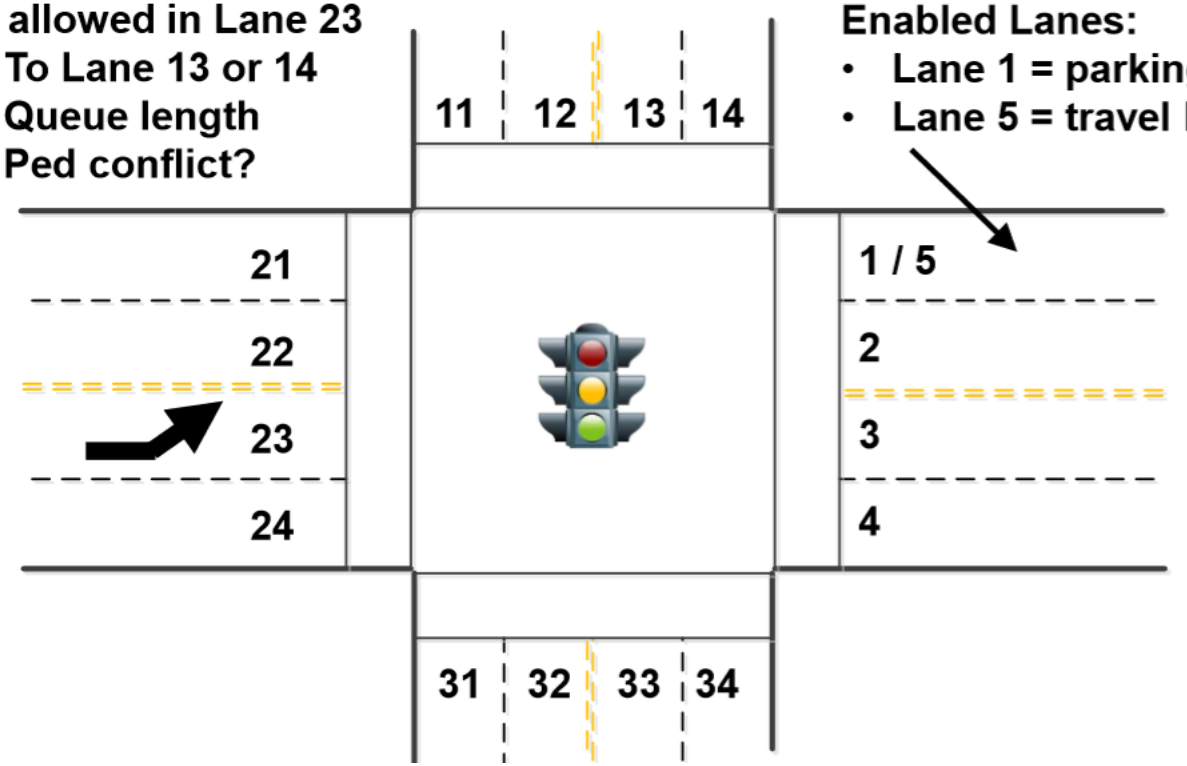
J 2735 SPaT Message

- Used in conjunction with a MAP message
  - The MAP message defines the lanes and the possible movements at the intersection
    - The MAP message does not change unless the roadway geometry changes
  - The SPaT message identifies the enabled lanes and additional dynamic information for a movement
  - signalGroupId – links the SPaT with the MAP

J 2735 SPaT Message

Maneuver assist

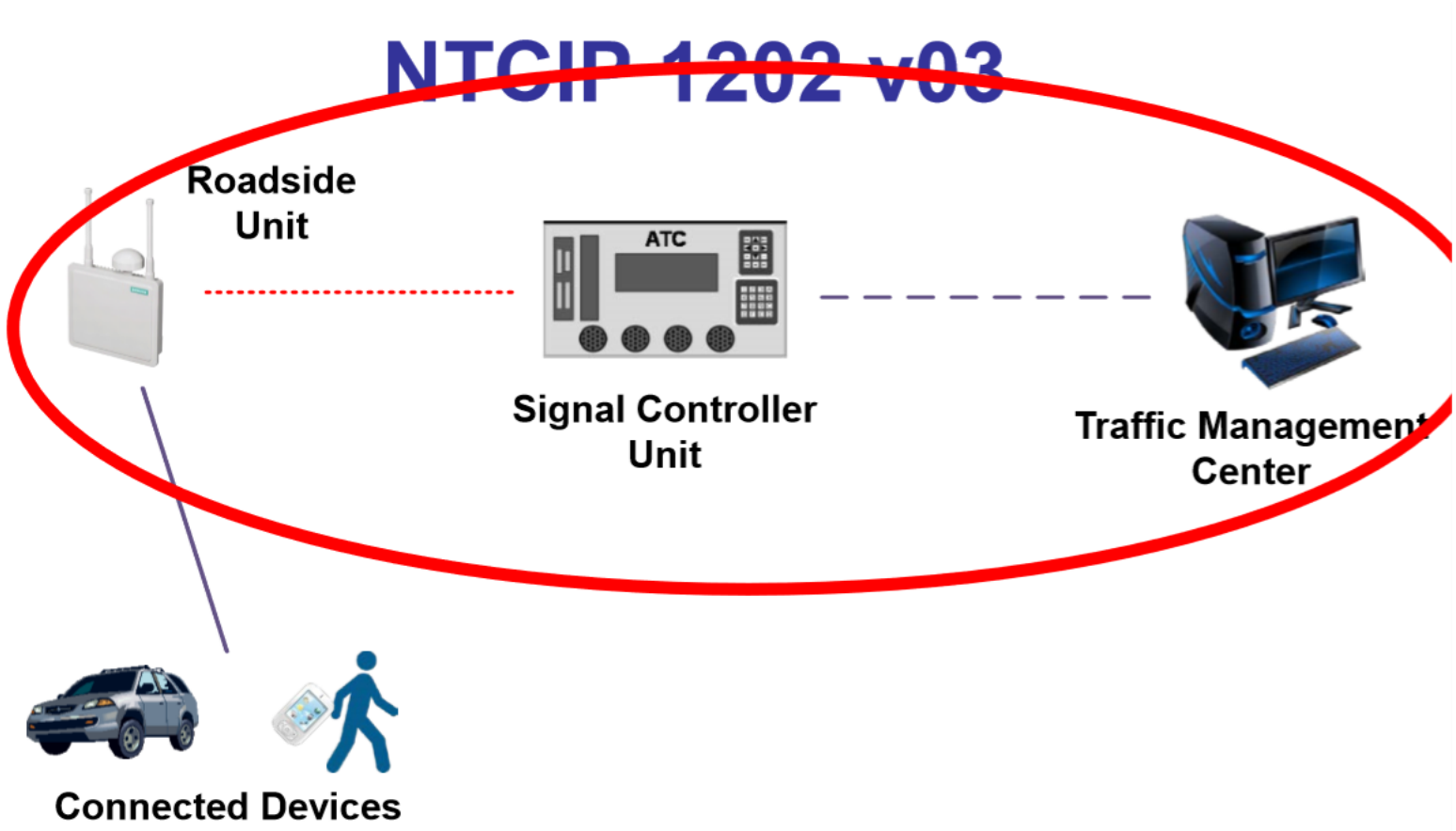
- **Left allowed in Lane 23**
  - **To Lane 13 or 14**
  - **Queue length**
  - **Ped conflict?**



Enabled Lanes:

- **Lane 1 = parking lane**
- **Lane 5 = travel lane**

NTCIP 1202 v03



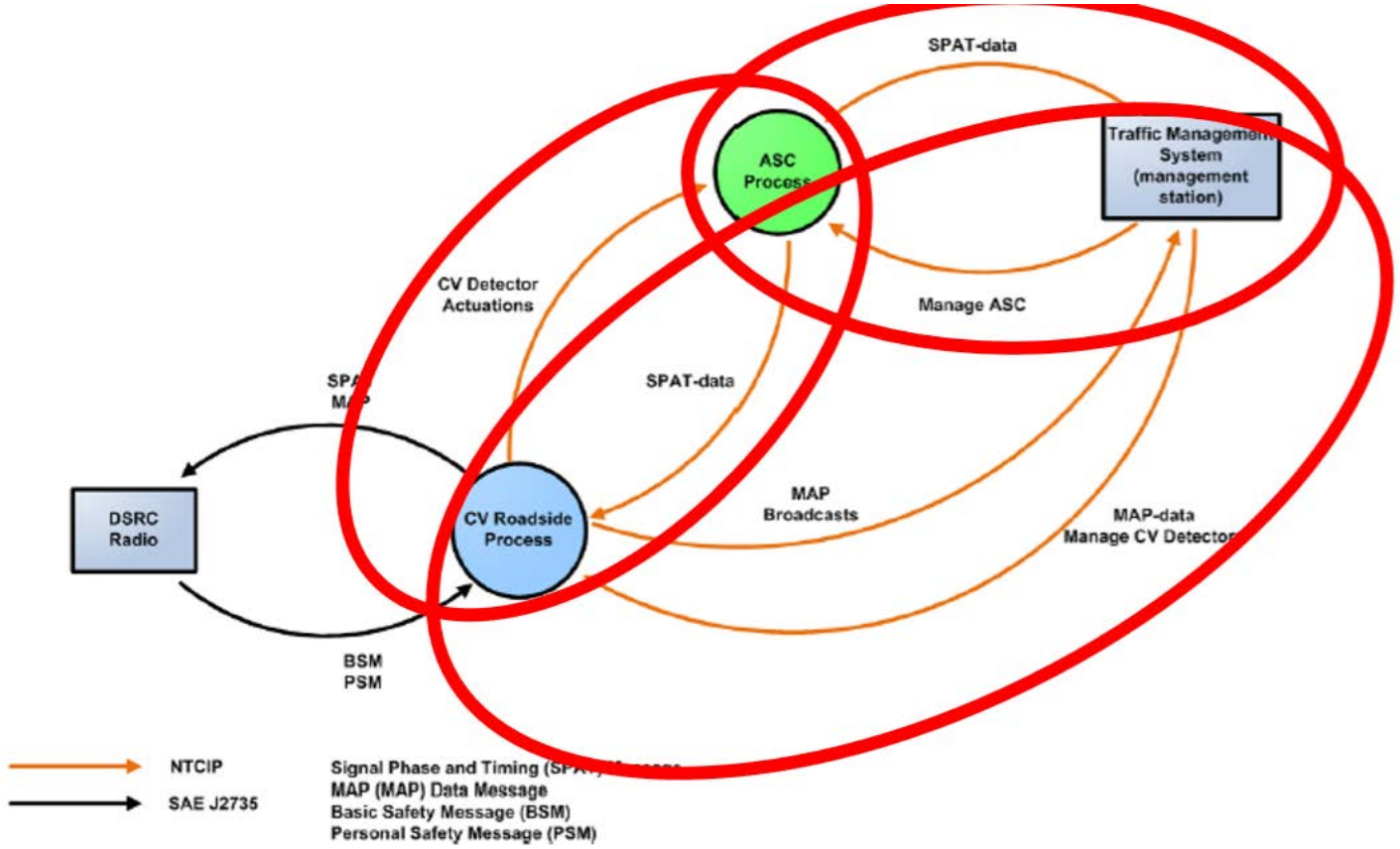
NTCIP 1202 v03

- Object Definitions for Actuated Signal Controllers (ASC) Interfaces
  - Version 3 adds systems engineering content, support for the cabinet environment, managing I/O mapping, exception reporting, and support for connected vehicles
  - Version 3 is currently in ballot.

NTCIP 1202 v03

- Connected Vehicles Interface
  - Configure the interface between a controller and a RSU
  - Generate and exchange SPaT data
  - Generate and exchange MAP data
  - Receive Basic Safety Messages and Personal Safety Messages as detector inputs

NTCIP 1202 v03 - Architecture



NTCIP 1202 v03 - Architecture

- Different physical architectures
  - The ASC process is part of the controller unit
  - The CV Roadside process
    - In the same physical unit as the DSRC radio
    - In the same physical unit as the controller unit
- Supports different architectures between the ASC and RSU
  - Who is the manager?
    - Does the ASC “push” SPaT data to the RSU, or does the RSU “pull” SPaT data from the ASC
    - Each has benefits and issues
    - May be determined by the policies of each agency
    - Must be defined in the specification

Current TDOT Activities

DSRC Statewide Guidance – Highlights

- Purpose and Intent
- Summary of Research
- Implementation Guidance
- Design Process
  - Roles and Responsibilities
- Design Elements
- Integration and Testing
- Maintenance and Operation

DSRC Statewide Guidance – Purpose and Intent

Purpose

The purpose of this document is to provide guidance for the deployment of Dedicated Short Range Communication (DSRC) technology on traffic signals within the state of Tennessee. This document does not cover the deployment of DSRC for freeway applications. Connected Vehicle (CV) technology is changing rapidly. This document captures the initial effort of the Tennessee Department of Transportation (TDOT) to deploy technology such as DSRC on signalized intersections. This is a living document that will be updated as technology changes and the programmatic deployment of DSRC matures within TDOT. The TDOT Specifications Committee will be engaged to develop standard specifications and drawings based on this guidance document. This process will take time and will result in updated versions of this guidance document. Updates to this document will be published via the Traffic Operations Memorandum (TOM).

Intent

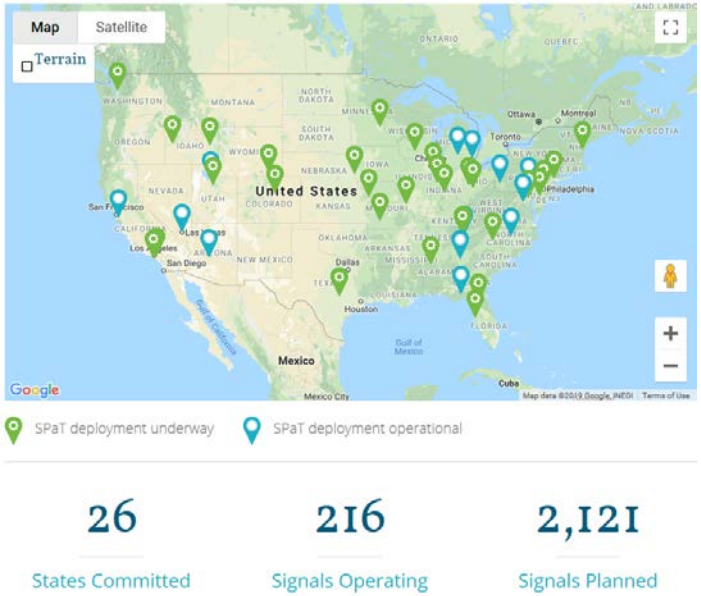
The DSRC statewide guidance document is intended to present a single resource for scoping, designing, and implementing a CV project as part of the Traffic Operations Program in Tennessee. The components of the CV system referenced herein is like many other devices used within TDOT's Traffic Engineering and ITS programs, however the process of design and integration are slightly different. For example, TDOT uses wireless communication technology and Advanced Transportation Controllers (ATC) in traffic signals. This document will provide both TDOT Project Managers, design consultants, system integrators, and general contractors with relevant standards that should be used in the design and implementation of a connected vehicle deployment using DSRC.

DSRC Statewide Guidance - Summary of Research

- Valuable insight gained from SPaT Challenge partners and other agencies at various stages of Connected Vehicle deployment. Sample of agencies consulted:

NOCoE National Operations Center of Excellence

UDOT Keeping Utah Moving



Caltrans

TATMS Tallahassee Advanced Transportation Management System

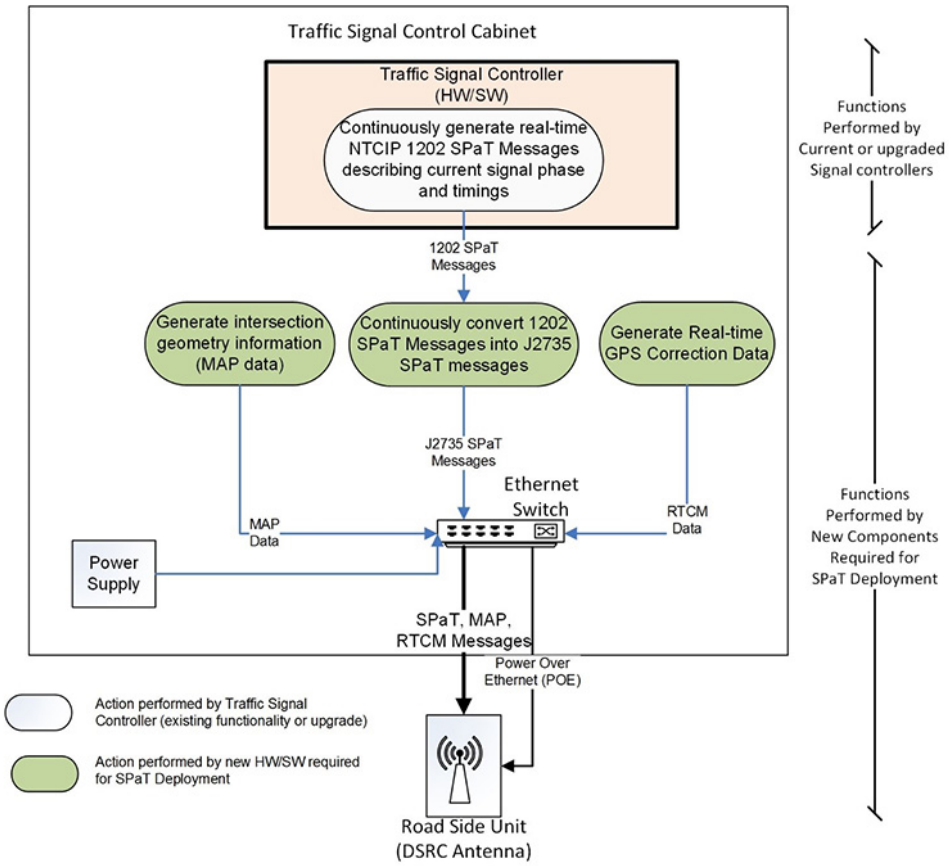
FDOT

CHATTANOOGA SEAL TENNESSEE

CITY OF KNOXVILLE MADELINE ROGERO, MAYOR

DSRC Statewide Guidance – Implementation

- SPaT Message Output from controller
- Conversion of 1202 SPaT Message (NTCIP format from controller) to J2735 SPaT Message (SAE format that car can understand)
- Generation of MAP Message
- Generation of GPS Correction
- FHWA – JPO -17-589 DSRC RSR Specification
- FCC Licensing and Spectrum Management
- Existing and New Hardware Requirements
- Equipment performance requirements

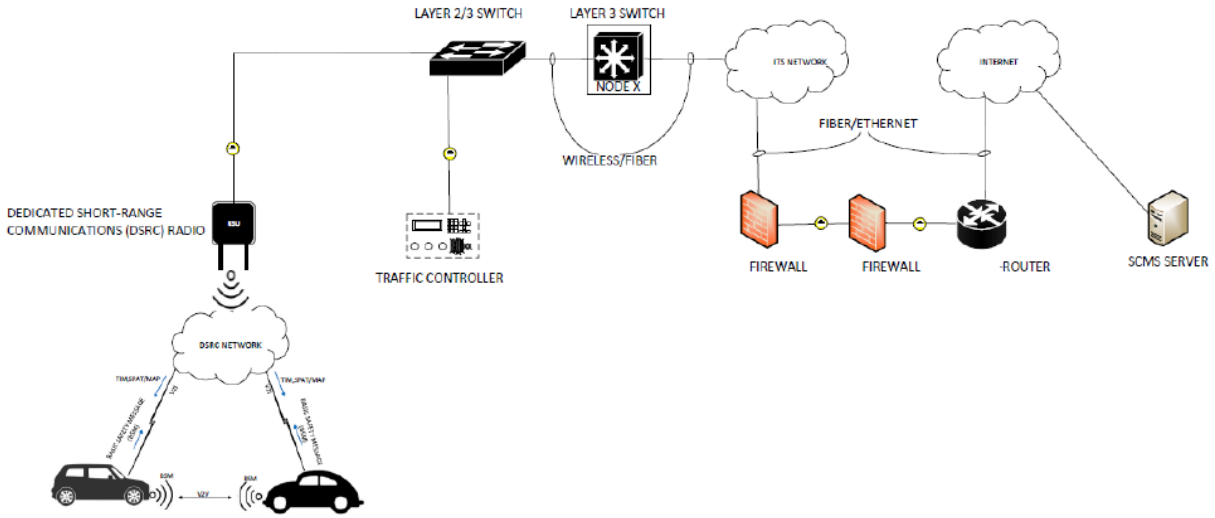


DSRC Statewide Guidance – Design Process

- Designer
  - Traffic Engineer; operational use case; intersection geometry;
  - ITS Network Architecture; coordination with all stakeholders
- General Contractor
  - Integration; message set format; communication paths
- TDOT
  - Set guidance; develop standards; facilitation; FCC license management
- Signal Maintaining Agency
  - Operate and maintain infrastructure; data managment

DSRC Statewide Guidance – Design Elements

- Road Side Unit (RSU)
- Managed Field Ethernet Switch
- ATC Controller
- Backhaul Communication
- On Board Unit (OBU)



DSRC Statewide Guidance – Integration and Testing

System integration and testing of the CV devices will be completed by the General Contractor/System Integrator. System integration and testing requirements includes the following:

- Complete the network integration and configurations of CV devices into the Local Agency ITS communication network
- Coordinate with TDOT and the Local Agency to file the required DSRC licensing forms with the FCC
- Configure the backhaul communication
- Upgrade the firmware of the RSU's to the latest standards/certifications as needed.
- Upgrade the firmware of the Traffic Signal Controllers as needed, to support SPaT broadcast
- Conduct testing required to prove functionality and operation for local, subsystem and final system.
- Assist TDOT as needed during the testing of the applications with their partners.

Current TDOT Activities

Next Steps

- Training for TDOT staff
- Training for signal design community
- Lessons Learned from I-24
- Vision for future of DSRC in Tennessee
  - Partner with local signal agencies who are preparing for V2X technology such as DSRC
    - Chattanooga
    - Knoxville
    - Others

Summary

Statewide DSRC Deployment…….

……is a huge undertaking

……must be built on a sustainable foundation of well maintained infrastructure

And…….

…..We must collaborate in order to be successful

- TDOT
- Local signal agencies
- OEM/Automotive Industry
- Academia
- Engineering Consultants
- Equipment vendors & Contractors

DSRC Costs Estimates Per AASHTO

- Roadside Equipment and deployment
  - $12K to $18K per intersection
- Backhaul communications
  - $4K to $40K (existing?)
- On-going operations and maintenance
  - $2K to 3K per year

Is DSRC the Betamax Version of CV?

*Current Advantages of DSRC:

1. It has a well-established standards for the equipment and messages.
2. It has been tested in robust environments for a decade.
3. It has a dedicated spectrum.
4. It communicates messages a very low latencies.
5. Certifications bodies are involved in verifying the performance of devices.
6. There is a large group of experienced agencies and individuals who are sharing best practices.
7. The communications does not require a subscription fee.
8. It is commercially available and in active use.

***Provided by Blaine Leonard, P.E., UDOT**

How long can we wait for standardized CV?

- **In 2018, researchers at the University of Michigan Transportation Research Institute completed a study (Sayer, Flannagan, and Leslie, "The Cost in Fatalities, Injuries, and Crashes Associated with Waiting to Deploy Vehicle to Vehicle Communication") which quantified the cost of delaying deployment of safety-critical applications. Specifically, they evaluated the cumulative number of lives which will be lost if we wait even three to five years for a new technology to be developed and proven. They concluded that tens of thousands of lives can be saved by deploying DSRC now.**

Thank You!

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