Traffic Signals and Connected Vehicles

Nader Ayoub, PE
Current standards

Basic CV Messages - from SAE J2735 – broadcast to vehicle

- SPaT (Signal Phase and Timing)
  - current signal state
  - time until change

- MAP (Intersection Map)
  - geometry of the intersection
Traffic signal information display in vehicles

- Indicator on the instrument panel shows countdown timer with predicted time to green
- Data analysis company predicts the timings and sends SPaT and MAP messages to manufacturer which sends to vehicle
- Will be blank if it can’t be predicted
Early deployments: Las Vegas, NV and Frisco, TX

• Key to success – close working relationship

• Each partner plays a critical role:
  ▪ Agency
    o Infrastructure
  ▪ Controller Manufacturer
    o Data Source
  ▪ Analytics Providers
    o Models traffic and provides data to auto manufacturer
  ▪ Auto Manufacturers
    o Provides a mechanism to display information to the driver
Current Traffic Signal Data Uses

• Safety
  ▪ Reduce Red Light Running
  ▪ Collision Avoidance

• Efficiency
  ▪ Engine Management
  ▪ Energy recapture

• Driver Information
  ▪ Can reduce stress with knowledge
Role of Traffic Signals in Connected Vehicles

- Data collection hub
- Standards-based data provider to vehicles and services
  - SPaT (Signal Phase and Timing)
  - MAP (Intersection Map)
- Platform for connected vehicle applications
- Analysis, optimization, and timing/phasing adjustment based on data
Intersection controllers of the past

- Single purpose box
- Proprietary hardware/software
- No ability to add additional applications
- No interoperability

Modern ATC Controllers

- Standards-based
- Linux-based operating system
- Faster Processors
- Support to run multiple applications
- Provide access to shared controller resources
Connected Vehicle intersection requirements

- Modern ATC Controller
- NTCIP 1202 v3.05 for SAE J2735 messages
- Connected Vehicle Applications
  - Standalone box or integrated into controller
  - Some applications in DSRC radio
- Communication between controller and vehicle
  - DSRC radio
  - Cellular communication
- Communication to Traffic Management System
- Design/planning, installation, setup, training, maintenance, ongoing software license fees
AASHTO DSRC RSE Cost Estimates

- 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

Source: NCHRP 03-101 COSTS AND BENEFITS OF PUBLIC SECTOR CONNECTED VEHICLE DEPLOYMENT
CV Technology will change how signals think

• Control algorithms will have access to individual vehicle speeds, classification, positions, arrivals rates, acceleration / deceleration, queue lengths….

• Optimization will be based on a better understanding of all vehicles at the intersection and not just if a vehicle is passing over a detection point.
CV impact on the practice of Traffic Engineering

- Better data for adaptive control and performance measures because queues won’t pass upstream detection
- Performance measurements such as delay will be measured more accurately in real time instead of simulated off-line
- Priority and control algorithms based on origin – destination

Source: Next Generation Traffic Control with Connected and Automated Vehicles  Henry Liu  Department of Civil and Environmental Engineering  University of Michigan  Transportation Research Institute  University of Michigan, Ann Arbor

Demonstration Projects

• New York City Pilot
  ▪ Improved safety for travelers and pedestrians
  ▪ Evaluate CV technology and applications in tightly spaced urban environments

• Wyoming Pilot
  ▪ Focuses on the needs of commercial vehicle operators

• Tampa Pilot
  ▪ Will deploy V2V and V2I applications to relieve congestion, reduce collisions, and prevent wrong way driving
  ▪ Will employ Dedicated Short Range Communications (DSRC)

• Mcity and MTC testbed in Ann Arbor
  ▪ Connected Vehicle
  ▪ Autonomous Vehicle
Early deployment applications of CV for traffic signals

Early deployments may include a limited subset of vehicles that would benefit from priority algorithms

- Transit Signal Priority
- Emergency Vehicle Preemption
- Heavy Trucks Signal Priority
The transition to Connected Vehicles

• Timeframe?

• Infrastructure enhancements

• Urban areas will lead the way

• Increase safety for all road users
  ▪ Must accommodate vulnerable road users

• Traffic Signals
  ▪ Allocation of Right of Way
  ▪ Advanced data usage in control strategies
Traffic Signals and Connected Vehicles

“Rumors of my demise have been greatly exaggerated”

Mark Twain