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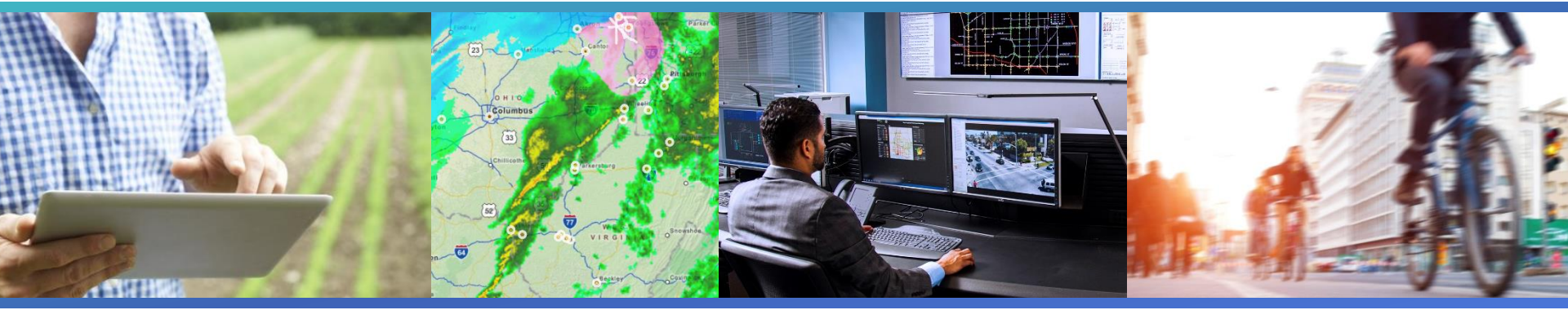


# Traffic Signals and Connected Vehicles

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



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# 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




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# Early deployments: Las Vegas, NV and Frisco, TX

- Key to success – close working relationship
- Each partner plays a critical role:
  - Agency
    - Infrastructure
  - Controller Manufacturer
    - Data Source
  - Analytics Providers
    - Models traffic and provides data to auto manufacturer
  - Auto Manufacturers
    - Provides a mechanism to display information to the driver




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# Current Traffic Signal Data Uses

- Safety
  - Reduce Red Light Running
  - Collision Avoidance
- Efficiency
  - Engine Management
  - Energy recapture
- Driver Information
  - Can reduce stress with knowledge




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# 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



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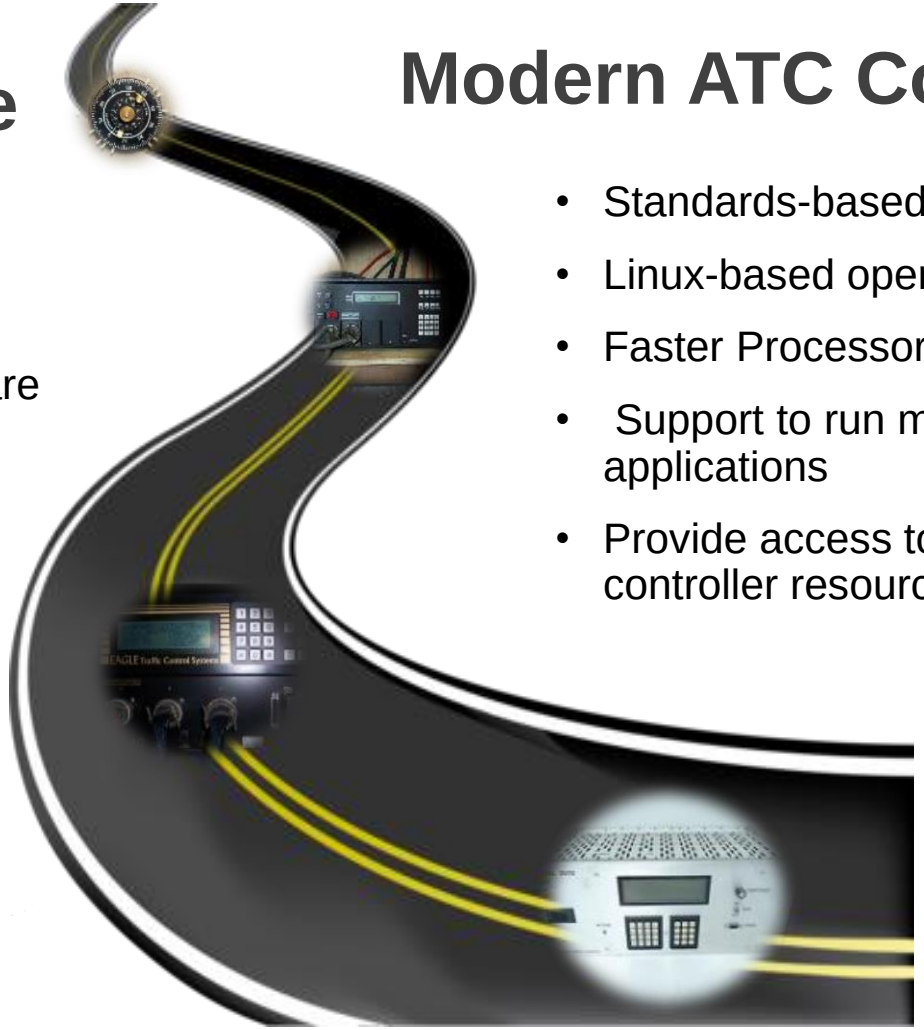
# Intersection controllers of the past

- 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



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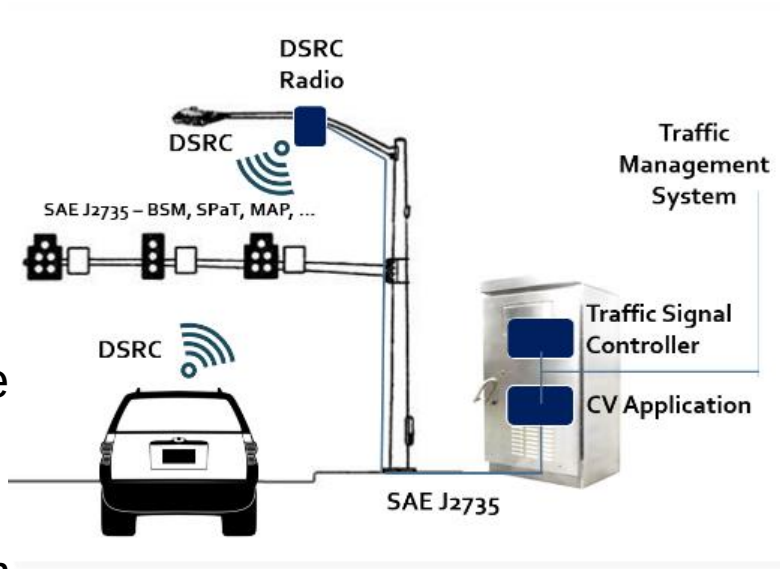
# Connected Vehicle intersection requirements

- 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, on-going software license fees



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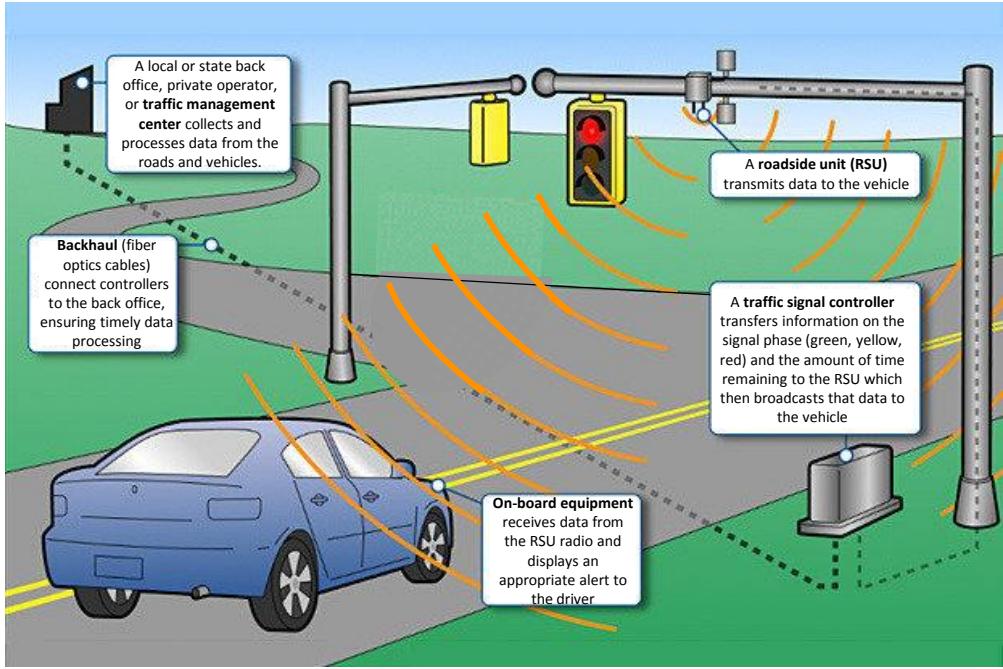
# AASHTO DSRC RSE Cost Estimates

- 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*



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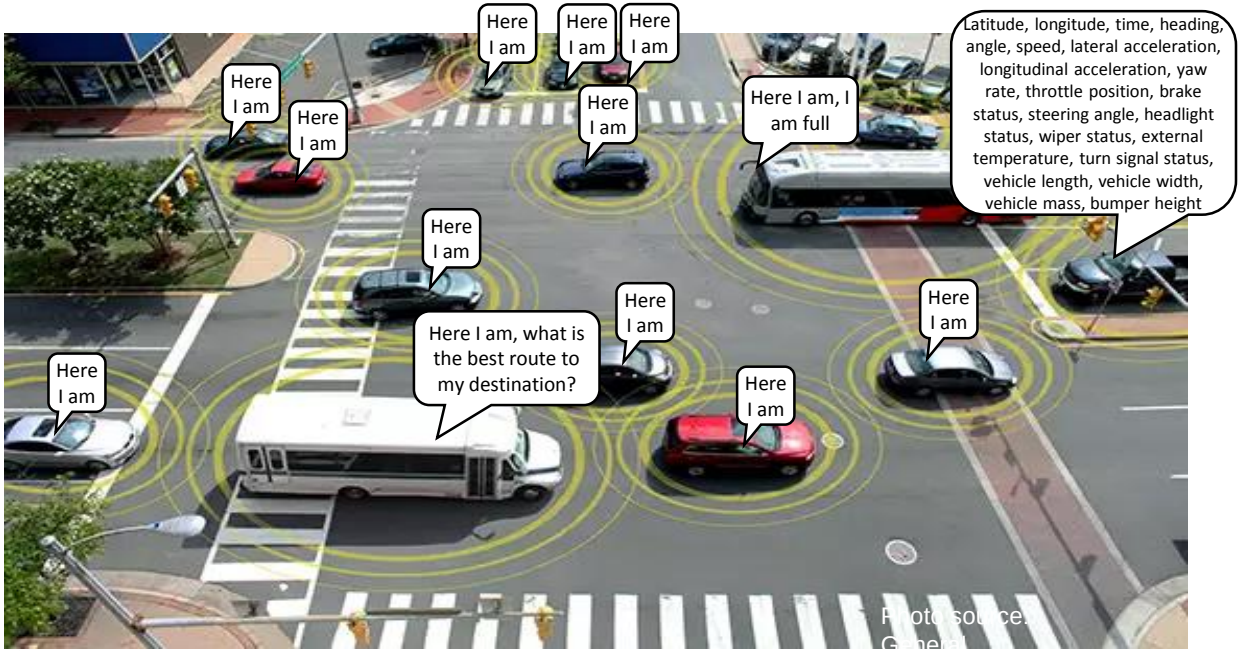
# CV Technology will change how signals think

- 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



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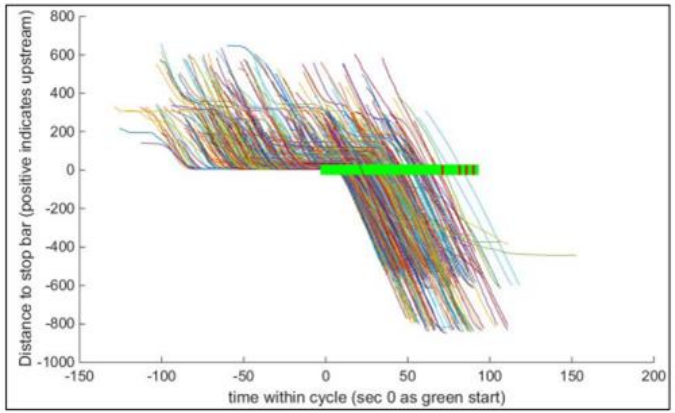
# CV impact on the practice of Traffic Engineering

- 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: NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM NCHRP REPORT 812 Signal Timing Manual Second Edition, Tom Urbanik*




*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*



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# 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



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# 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



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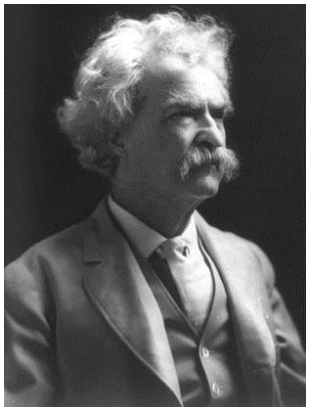
# Traffic Signals and Connected Vehicles

"Rumors of my demise have been greatly exaggerated"



Mark Twain



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