Connected Vehicle Analysis in Smart Marysville Pilot

OTEC October 2 – 3 2018
What is the Connected Marysville Project?

— Connected Vehicle Deployment Pilot
— Heavy Emphasis on Research Data
— Led by ODOT Office of Statewide Planning and Research
— Targets drivers that frequent the city streets of Marysville
— Coordinates and leverages other local and regional CV activities
Goals

— Increase CV penetration by 400 vehicles
— Collect and analyze rich new source of data
— Specify ways to react to this data
— Identify what is necessary to operate and maintain a CV environment
  — Tools,
  — Processes and
  — Policies
— Identify measures to keep this environment secure
— Affect positive change on the transportation infrastructure.
Background / History

— Columbus selected as USDOT Smart City Challenge winner in June 2016
  — *Includes a large CV element (~2000 vehicles)*
  — *Smart Columbus Operating System (data exchange) is the foundation*

— Marysville, Union Co., and Dublin selected as ATCMTD grant recipient in Aug 2016
  — *Purpose to Deploy CV Roadside Units along US 33 and in Marysville & Dublin*
    — *Includes >800 CV*

— ODOT Deploys fiber along US33 to support US 33 Smart Mobility Corridor – Oct 2017

— ODOT Research issues Connected Vehicle Analysis in Smart Marysville Pilot
### Project Phases

- Four (4) Phases
  - Design - Current
  - Pilot
  - Analysis
  - Reporting

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**Timeline:**
- Phase 1: Design - Apr-Oct 2018
- Phase 2: Recruit / Deploy - Jul '20 - Oct '20
- Phase 3: Analysis - Jan '19 - Jun '20
- Phase 4: Reporting - 6 mo.

**Duration:**
- 1 year
- 4 mo.
Phase 1 Scope

— Develop Plan for conducting CV Pilot focused on the connected intersections in Marysville

— Includes
  — Design of Experiment
  — Recruitment Plan
  — Technology Assessment
  — Scope, Schedule and Budget
Design of Experiment

— Included in Deployment Plan
— Based on following eight (8) CV Apps
  — Pedestrian in Signalized Crosswalk Warning (PCW)
  — Spot Weather Impact Warning (SWIW)
  — Curve Speed Warning at interchange ramps
  — Queue Warning (Q-WARN)
  — Reduced Speed Zone Warning / Lane Closure (RSZW/LC)
  — Red Light Violation Warning (RLVW)
  — Ramp Wrong-Way (maybe, depending on budget)
  — Railroad (maybe, depending on budget)
— Certain Measures require advanced data from OBD-II / CAN – limited scope
Design of Experiment

— Three levels of data

— BSM Part 1: ▪ Contains the core data elements (vehicle size, position, speed, heading acceleration, brake system status) ▪ Transmitted approximately 10x per second

— BSM Part 2: ▪ Added to part 1 depending upon events (e.g., ABS activated) ▪ Contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies) ▪ Transmitted less frequently

— Aggressive Integration
Design of Experiment – Data Items

— Connected vehicle data:
  — Obtained directly from equipped vehicles, providing vehicle kinematic and geospatial information and trip summaries.
  — BSM data containing vehicle attributes (e.g., location, speed, heading, brake application, status of wipers)
  — RSE data that consists of messages transmitted or received by RSEs, including BSMs, signal phase and timing (SPaT) messages, and traveler information messages (TIMs).

— Additional system data:
  — Weather data
  — Traffic mobility data (e.g., counts, travel time)
  — Network safety data (e.g., occurrence of crashes)
  — Network data events (e.g., incidents, work zones, other special events)
  — Naturalistic driving data that are collected from onboard cameras that records driver behavior
  — Survey data (e.g., stated preference) on driver’s attitudes toward CV technologies, such as acceptance and willingness-to-pay
Design of Experiment – Application Evaluation

— Collect data for statistical analysis of effectiveness of CV applications
  — before and after data
  — Data w/ and w/o CV application

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  — before and after data
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  — Data collection period (at least 3 – 6 months for safety applications)
Design of Experiment - Performance Measures

— Safety:
  — Safety risk hotspots (potential crash points with high frequencies) identified using the horizontal acceleration data generated by connected vehicle devices and/or extracted from video cameras; risks can be measured using surrogate safety measures
  — Crash frequencies

— Efficiency:
  — Vehicle travel times or delays
  — Delay, queue lengths and intersection saturation (e.g., volume-to-capacity ratio)

— Environmental impact:
  — Fuel consumption data or estimation
  — Local air quality detection (e.g., RWIS sensors) through potential environmental sensors to be deployed at the roadside
Design of Experiment – Data Use

— Traffic System Evaluation
  — Provide archived and real-time traffic performance, including travel time, speed, and queue length
  — Data fusion with existing detectors
    — Link or route travel time, intersection/corridor travel time
    — Accurate driver behavior understanding and modeling, such as headways, reaction time, and lane-change gap acceptance, providing the foundation for future capacity analysis
    — Travel time reliability (origin-destination-based or linked based)
    — Driver behavior before crashes (predictive)
  — Signal timing optimization
    — Time of day
    — Real-time / adaptive signal control
Design of Experiment – Data Use

— Infrastructure Safety Assessment
— data from vehicles themselves and OBUs (esp., vehicle accelerations, locations, speeds)
— identify infrastructure safety “hot spots”
  — safety-critical events, defined in this context as crashes, near-crashes, and other unsafe driving behaviors using kinematic data from single vehicles
Design of Experiment – Data Use

— Infrastructure Pavement Assessment
  — vehicular kinematic data to assess pavement conditions
  — Traditional measure: IRI (International Roughness Index)
  — New acceleration-based metric
Design of Experiment – Data Use

— Connectivity/Communication Performance (V2I & V2V)
Design of Experiment – Data Use

- Willingness-to-pay for CV technologies
  - Stated preference survey after using the technology
- Highway Capacity Manual (HCM) Additions
  - Different market penetration of connected (and automated) vehicles at freeway segments, merge, diverge, and intersections
- Calibration of simulation models
  - Behavioral modeling
  - Communication modeling
  - Demand modeling
  - Large System Benefit Estimation
Recruitment Plan

- Goal: 400 Private Vehicles
- Challenge: Likely need to recruit 1,600 individuals
- Will need to incentivize – there is a time cost for participants
- Recruit drivers per specific age groups
- IRB will be implemented - this is Research
- Draw from Schools and Local Employers
- If you meet this criteria – do contact us
Technology Assessment

— Multiple suitable vendors
— Low-cost is not best option
— HMI is major consideration
— Recommend thru the glass antenna
— Limit OBD-II / CAN connectivity to vehicle groups
— RSUs must support OTA updates and data collection
— Detection equipment needs to be thoroughly vetted
— SCMS TBD – may need to use commercial
Pilot Plan

— Phase 2 - Pilot
  — 18 months
  — First 6 months include OBU procurement, recruitment and installation
  — Looking to create workforce development opportunities

— Phase 3 – Analysis
  — Start ~6 months after Phase 2
  — Leverage Smart Columbus Operating System

— Phase 4 – Reporting
  — Initiates after Pilot phase is complete
Pilot Plan
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