Presentation Layout

AASHTO Challenge
Intro to SPaT & DSRC
  Hardware
  Soft Side
  Schemes

WSDOT Projects
  Locations
  Systems Engineering
  Needs assessment
  Estimates

Future Trends
SPaT Challenge

What is the AASHTO Challenge?
- To challenge state and local transportation infrastructure owners and operators (IOOs) to achieve deployment of Dedicated Short Range Communications (DSRC) infrastructure with SPaT (and MAP) broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each state by January 2020

Purpose of the Challenge is:
- To provide IOOs with an entry into DSRC-based V2I deployment and procurement, licensing, installation, and operation experience:
  - Show a commitment to OEMs and applications developers

What are the benefits?
- Be more prepared for DSRC-equipped vehicles and on-board applications and useful as test bed for them;
- Supports deployment of V2I/PID applications that build on SPaT at intersections:
  - Improved Safety and Mobility for traveling public
  - Improved Safety for Pedestrians
  - Access for Active Transportation and Vulnerable Users
  - Smart Transit/ Freight Signal Priority
  - Red Light Violation Warning
  - Eco-Driver
  - Etc.

We have to start small . . . and scale up!

Source: NCoE
DSRC Service

• The DSRC operates in the 5850 – 5925 MHz band (the 5.9 GHz band), and coexists as a primary use along with other Federal users authorized by the National Telecommunications and Information Administration (NTIA), as well as with a number of commercial satellite operators.

• Responsibilities include
  – Reviewing FCC service rules, regulations, and technical requirements; field deployment and planning;
  – Licensing administration and ongoing management activities.
  – Coordination with Existing Co-Primary Users (e.g. Fixed Satellite)
  – Radio Frequency Analysis and Survey of "Unlicensed" Systems (e.g. Wi-Fi)
  – Security Credentialing and Service/Application Commissioning
SAE J2735-2016 Messages

- A Signal Phase and Timing (SPaT) message defines the current and future steps of the intersection traffic signal phases; Current state of all lanes at intersection are provided, as well as any active pre-emption or priority.

- Various Schemes
  - V2i HUB or ASC
  - DSRC or Cloud

- Compliant messages for broadcast
  - SPaT – Signal Phase and Timing
  - MAP – Intersection Geometry
  - BSM – Basic Safety Message
  - SRM – Signal Request Message
  - SSM – Signal Status Message
  - TIM – Traveler Information Message
  - RTCM - The Radio Technical Commission for Maritime Services, Position Correction
  - Future J2735 messages
Road Side & On Board Units (RSU, OBU)

Until OBUs are in place, how do we know?

- That MAP and SPaT is actually being broadcast?
- How far from the RSU can it be received?
- Can RSU receive Basic Safety Message (BSM)?
- What other applications could be deployed with OBU and RSU?
  - E.g. EV Priority/Preemption, Transit Priority, Freight Priority, P.M. Observation,…
MAP Message

- MAPs represent sets of related lanes;
  - Each lane is a closed polygon
  - Attributes define width, moves and prohibitions, etc.
  - MAPs support a 1 cm resolution

- Lines represent 8 different “lane types” with a common structure.
  - Includes: Motor Vehicles, Ped Lanes, Medians, Bicycle Lanes, Trains, etc.
  - Each Lane Type has the attributes it needs to describe its use case.

- BSMs can easily be placed on a flattened MAP for application use.
Messages Summary

- A typical MAP message has
  - One Intersection with
    - Many Lanes (each with a LaneID, and GroupIDs, in its ConnectsTo)

- A MAP message is Static,
  - And contains all relevant lane details

- The SPaT message is Dynamic,
  - All time of day details (which lane description is to be used at a given time of day)
    - Reversible Lanes
    - Time of Day Parking Lanes
    - Left Turn, Right on Red and other Crossing lanes that vary with time

- A typical SPaT message has
  - One Intersection (may not be one signal controller)
    - Active Movements, each with TimeMarks for GroupIDs
Systems Engineering Approach;

- System that meets user needs
  - Common understanding of intent
  - Stakeholders role
- Operational needs (Use Case Diagram)
  - User oriented operations
- Functional requirements
  - Concept(s) apps & functions
  - Operational scenarios
  - References for requirement
- Verification and Validation
  - Demonstration, test, analysis, inspection
- Traceability to needs
Infrastructure

- **Hardware Requirements**
  - RSU 4.1 Specification
  - V2i HUB (optional)
  - Back End
    - Cabling
    - Mounting

- **Software Requirements**
  - Messages
  - Performance
  - Security
  - Software Development Kit (SDK)
    - Needed for software development / modification

- **Implementation**
  - Procurement Variations
  - Applications Beyond SPaT
  - Outside Certification & Licensing
  - OBUs (optional)
  - Testing

### Cost Estimates

- **Hardware**
  - RSU
    - $1500 to $3200
  - Mounting Brackets, Cables, Power Supply
    - $200 to $600
  - OBU
    - $900 to $1500

- **Engineering**
  - Design / Testing
    - $1000 to $8500
  - Installation / Integration
    - $2000 to $11,000
    - Lane Closures / Night Work
  - Create MAP Data
    - $400 to $1500
    - Use of Tool
    - Local Mapping

- **Communication**
  - $4-$40K for the corridor.

- **O&M**
  - $2-$3K a year per intersection.
WSDOT Accepts the SPaT Challenge

- NWR-10 Locations along SR 522 North of Lake Washington through the Cities of Lake Forest Park and Kenmore,
- ER-4 Locations along US 2 North and West of the City of Spokane,
- OR-6 Locations along SR 305 from the Bainbridge Island Ferry Terminal to the City of Poulsbo,
- SWR-4 Locations along SR 500, between I-5 and I-205, through the City of Vancouver.
SR 522 Project

- 10 Intersections along Lake City – Bothell Way NE (SR 522)
  - Heavy commuter traffic
  - With recreational active users @ Burke Gilman Trail
Current Project Sponsors

- WSDOT Northwest Region Traffic Operations,
- WSDOT HQ Traffic Research,
- WSDOT Cooperative Connected Automated Mobility.
- Intelight ITS company—Hardware sponsor and integrator.
- University of Washington – Star Lab (UW) is partnering in developing an application for PID users
- Washington State University at Pullman (WSU) is partnering in research and testing of the system.
**Stakeholders**

**SPaT Infrastructure System**
A system that consists of new infrastructure that is added to securely communicate signal phase and timing and other safety and mobility information to vehicles and personal information Devices (PID) in order to support applications that interact with drivers and active transportation users. Depending on the applications deployed, the SPaT system may also receive data from Vehicles and PID systems (e.g., signal pre-emption/priority requests, and Basic Safety Messages).

**SPaT Vehicle System (OBU)**
The main user of the SPaT applications is the vehicle driver. However, the vehicle driver does not interact directly with the SPaT Infrastructure System, but instead interacts with the SPaT Vehicle System and therefore is considered an ‘indirect user’.

**Personal Information Device (PID)**
A second indirect user group are the active Transportation users crossing the intersection, specifically the pedestrian, Bikers, visually impaired or vulnerable pedestrians. Like the drivers, they will not interact with the SPaT Infrastructure System, but rather with Personal Information Devices (PIDs), typically hand-held devices that receive and transmit data and provide user information.
Active User Needs

- **Vision Impaired User**: Difficulty placing a call for a walk indication.
- **Vision Impaired User**: Difficulty discerning the current state of the walk/don't walk indications.
- **Bicycles**: Difficulty placing a call for a crossing indication and may be vulnerable to drivers who do not see them in Bike lane on the right.
- **Pedestrian**: During a permitted crossing time may still be vulnerable to drivers who do not see them in crosswalk.
Personal Information Device Needs

There is no mechanism for PIDs to send messages directly to Traffic Signal Systems to communicate cross requests.

There is no mechanism for PIDs to receive data or information directly from Traffic Signal Systems.

In order to accurately determine if pedestrians are outside the designated crosswalk, their position must be accurately determined.

PGPS
Vehicle System Needs

The driver of a commercial freight, transit or emergency vehicle approaching a traffic signal does not know if the signal will be green when the vehicle reaches the intersection, and so does not know if they need to prepare to stop at the intersection.

Providing Red Light Violation Warning (RLVW), Pedestrian in Crosswalk, Bike in Bike lane, and Eco Arrival / Departure (Eco A/D), applications require information from the SPaT Infrastructure System.

Arterial Traffic Signal Performance Measures and arterial traveler information would benefit from increased information about vehicles.
Security Needs

Back End Security
Risk of unauthorized systems imitating vehicles and sending data to the roadside equipment.

Back End Security
Risk of unauthorized systems imitating the infrastructure and sending inappropriate data to vehicles.

IT Dept
The agency must protect the signal controller, network, and central system that interfaces with the SPaT Infrastructure System from unwanted access or malicious intents.
DSRC Licensing

- WSDOT has a statewide geographic area license from FCC (valid until 2025).
- We need location licenses per each radio installed. (pending)
- Installation by State source
- Testing and reporting by WSDOT staff
SR 522 Cost Estimates

SR 522 project has a proposal of 70-80K for 10 intersections including: DSRC Antenna, MAP, OBU Module, SPaT License.

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<th>Description</th>
<th>Qty</th>
<th>Unit Price</th>
<th>Total</th>
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<td>DSRC RADIO-OBU: INCLUDES COMPLETE KIT WITH HUMAN INTERFACE DEVICE: ON BOARD COMPUTER DISPLAY UNIT (OBU) W/ POE INJECTOR</td>
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<td>Map File Configuration (Per Map)</td>
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- Backhaul communication for the corridor exists.
- Ongoing operations and maintenance $2-$3K a year per intersection,
One-stop shop for SPaT-related information

- Overview
- Current map with SPaT deployment details and contacts
- Resources:
  - Corridor Selection Guide
  - DSRC Licensing Guide
  - Concept of Operations Model
  - Functional Requirements Model
  - Advancing Automated and Connected Vehicles: Policy and Planning Actions for State and Local Transportation Agencies [NCHRP Report 845]

https://transportationops.org/spatchallenge
Future Trends

- **Market penetration forecasts:**
  - 32.4% no advance changes
  - 40% advanced features (WTP $1100)
  - 16.5% Partial Automation (WTP $1500)
  - 11.1% Fully AV (WTP +$2000)

- **Impacts of CV/AV on Traffic Signals (MMiTSC):**
  - Use of BSM, MAP, SPaT
  - Performance Observation, including ATSPM
    - Travel Time, Delay, Stop, AoG, Queue Length
    - Safety: Number of Conflicts
    - Movements: LT, Th, RT
    - Mode: Veh., Transit, Freight, Ped. Bike
    - Controls: Ph Call, Ph Extend, Dilemma Zone, Coordination
    - Adaptive Traffic Control
    - Priority control: EMS, Transit, Truck, Ped & Bike
Future Trends

- NTOC 2012 National Traffic Signal Report Card estimates approximately $83 Billion in public investment in more than 300,000 traffic signals.
- Cities range from 45 intersections per square mile (like Salt Lake City) to upwards of 550 (e.g., Portland, Ore).
- They all need to have digitized MAP information for SPaT at some point.
- Who will be in charge of this task,
  - Who pays for it?
  - Who maintains it?
Questions?

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