U.S. Department of Transportation
**Federal Highway Administration**

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# Connected Vehicle Eco GlidePath at Signalized Intersections

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## BACKGROUND

The Federal Highway Administration's Saxton Laboratory, along with its partners, has successfully implemented and demonstrated the application of eco-approach and departure to a signalized intersection on the connected campus of Turner-Fairbank Highway Research Center. This on-board software application automatically communicates with traffic signals at intelligent intersections and controls a moving vehicle's accelerating and decelerating speed in an eco-friendly manner.



Known as the Eco GlidePath, this prototype provides a tablet-based driver interface that provides the driver with signal phase and timing data in illustration form (as shown above).

## CONCEPTUAL FRAMEWORK

Numerous field tests were conducted at the FHWA with a single vehicle at a single intersection containing no traffic. Roadside Units on the FHWA campus allowed the vehicle to communicate with the traffic signals as they approached the intersection.

**OBJECTIVE:** Optimize environmental performance of a vehicle approaching and departing a signalized intersection

**INPUT:**

- Vehicle Location (distance to intersection)
- Vehicle Speed
- Signal Phase and Timing (SPaT) and MAP Messages
- Scenario/Environmental Thresholds:
  - Maximum speed, acceleration, deceleration, jerk, etc.

**OUTPUT:**

- Speed Trajectory
  - Target Speed updated at 10Hz
  - Target Acceleration/Deceleration transitions to minimize fuel consumption and bound "jerk" (da/dt) for passenger comfort
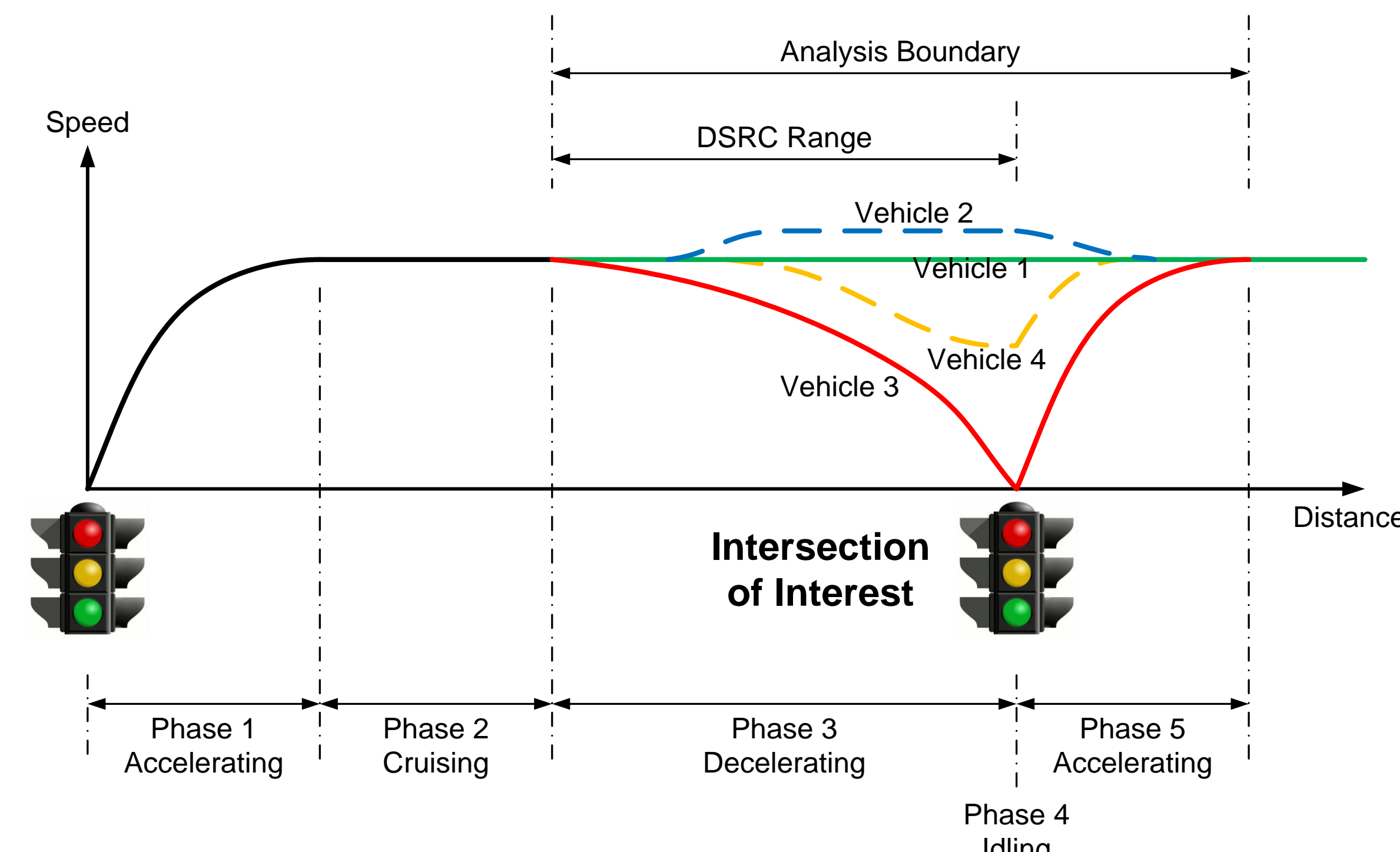


Illustration of different scenarios on recommended velocity trajectories in the Eco-Approach and Departure algorithm.

## HOW IT WORKS

When a vehicle approaches an intelligent intersection, it wirelessly receives two distinct DSRC messages describing the Signal Phase and Timing (SPaT) and intersection geometry. The on-board dashboard then calculates the current distance the vehicle has to travel to get to the stop bar of the intersection using the current position and speed of the vehicle. This allows the vehicle to maximize fuel economy by accelerating, decelerating, maintaining a constant speed, or stopping efficiently, creating the potential to save up to approximately 20% in fuel while smoothly driving through an intersection and respecting all traffic laws.
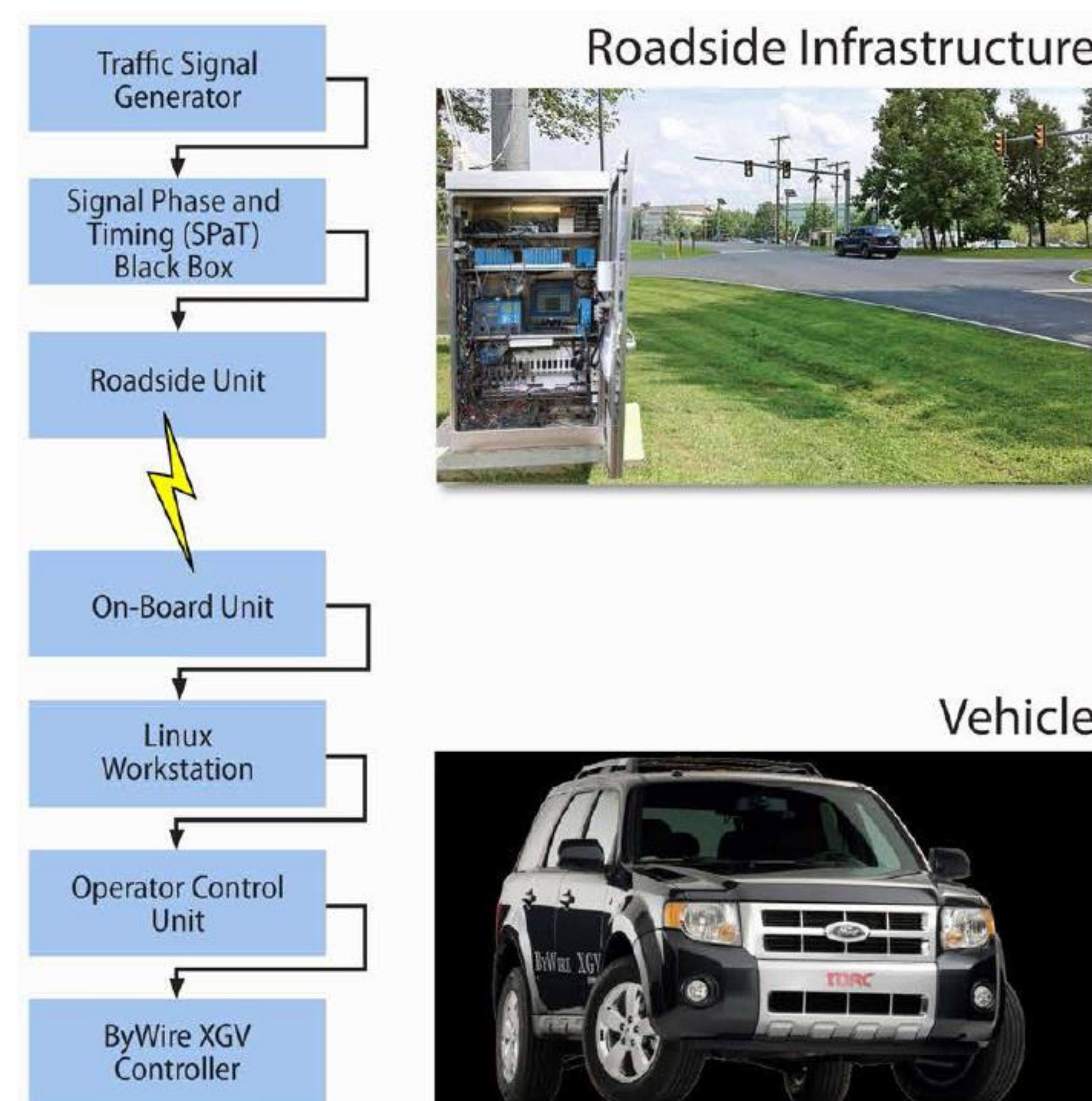


GlidePath Components and High-Level Diagram
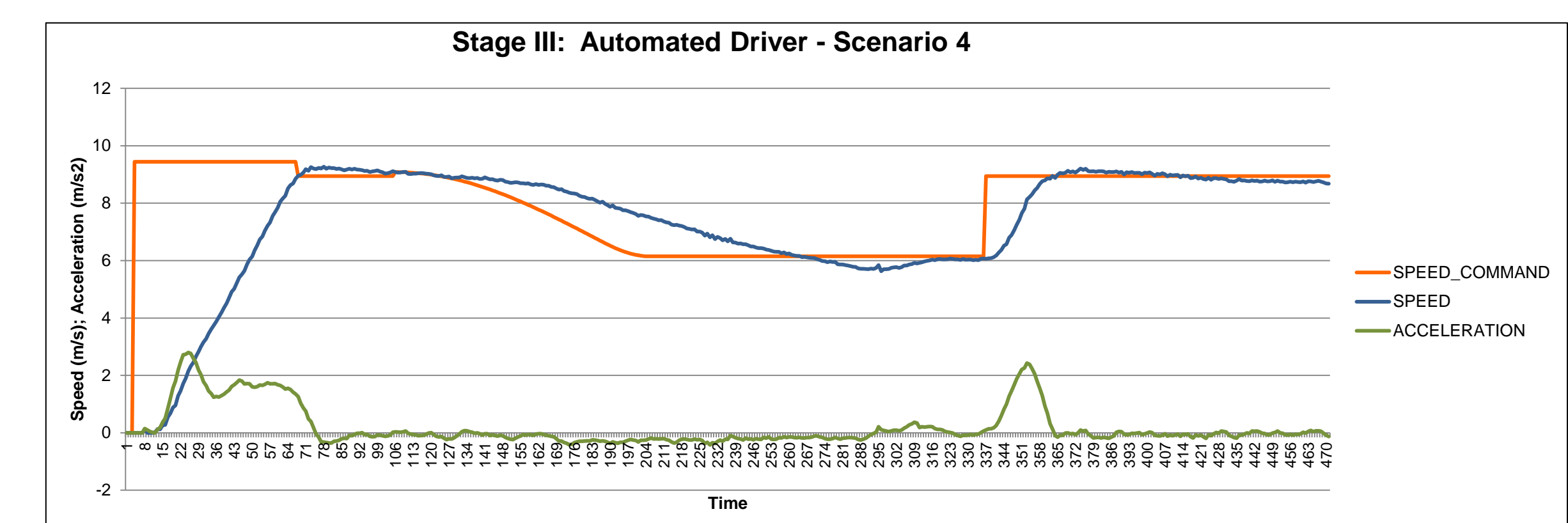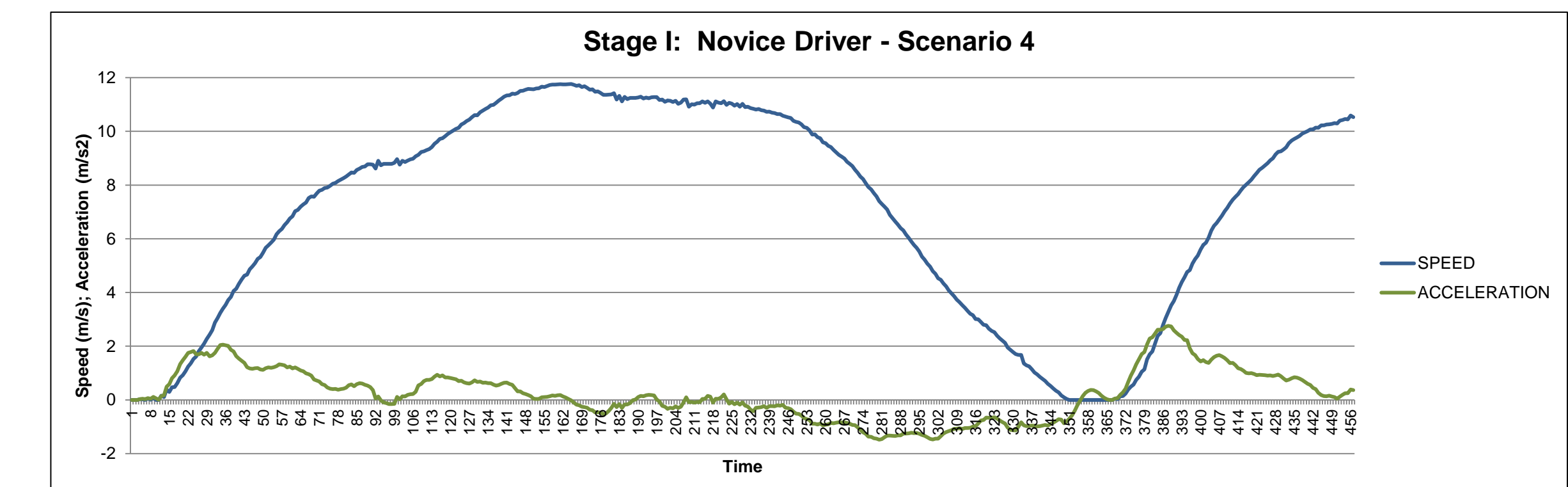


Example Run: Novice Driver vs. Automated Driver

| Speed (mph) | Average Fuel Savings (ml) | Sigma | Average % Improvement |
|---|---|---|---|
| 20 | 13.0 | - | 2.5% |
| 25 | 111.0 | 10.9 | 18.1% |
| 30 | 76.0 | 15.7 | 11.2% |
| 35 | 73.8 | 19.6 | 6.3% |
| 40 | 107 | 14.6 | 9.5% |

Preliminary data – AERIS EcoDrive study results showed improvements in fuel savings at different speeds

## MOVING FORWARD

With the successful implementation of the GlidePath prototype, FHWA has established a state-of-the-art foundation for continued research and development involving variable signal timing, multi-intersection applications, and accommodating vehicle-to-vehicle (V2V) communication in intersections. Eco-friendly driving solutions are paving the way for further investigation in the feasibility of applications such as the GlidePath with the goal to eventually conduct a small scale prototype/test for possible commercial deployment in the future.
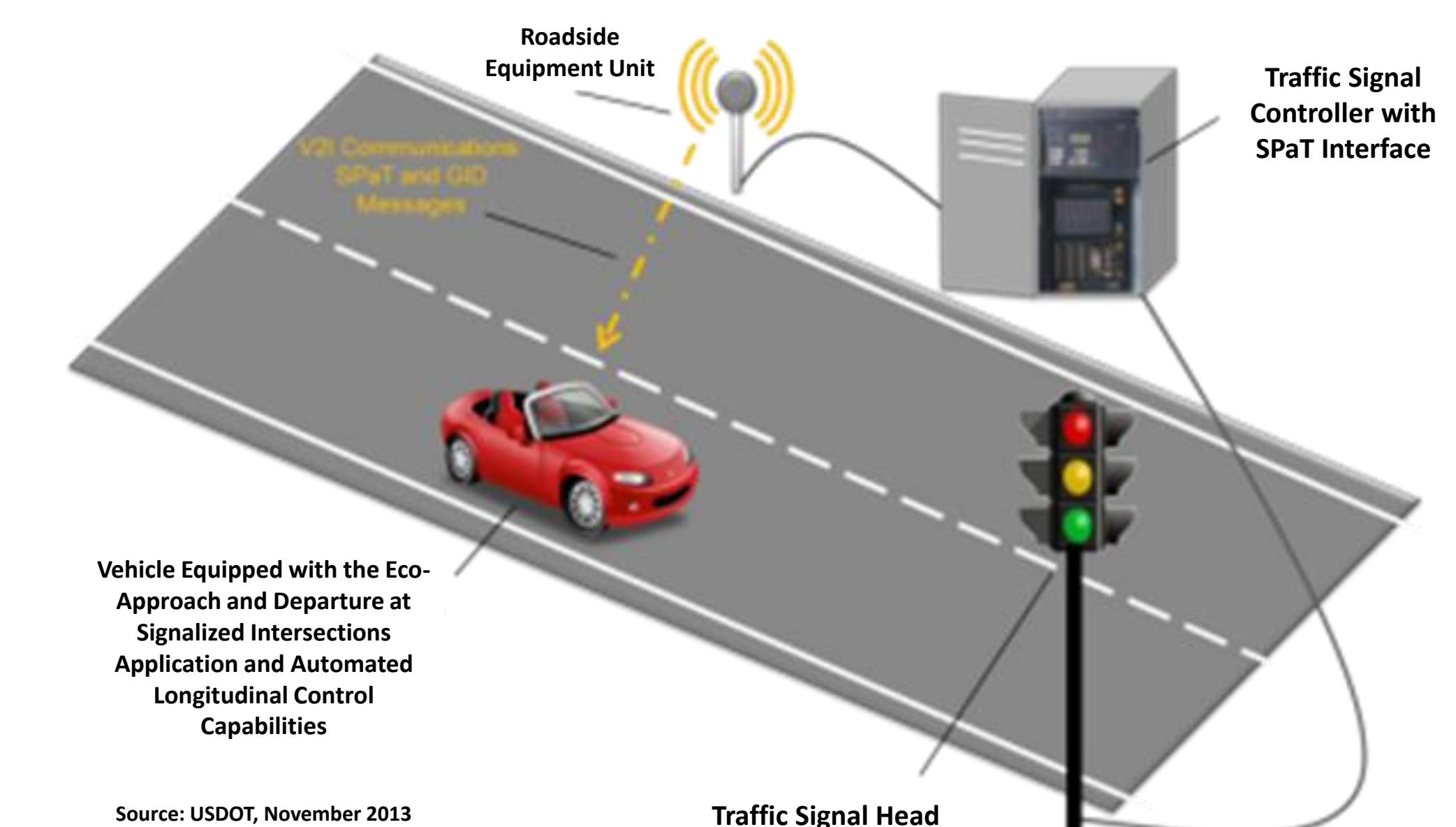


Concept for EAD at Signalized Intersections

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