Safety Pilot Model Deployment: Rx Basic Safety Messages

cmisst

Center for the Management of Information for Safe and Sustainable Transportation

INTRODUCTION

The Safety Pilot Model Deployment (SPMD) study was run in the Ann Arbor, MI area and involved over 2,000 vehicles. The study goal was to pilot a connected-vehicle system that included roadside units (RSUs) fixed to specific intersections and vehicle-based communication units. Data were collected from RSUs as well as vehicles.

Each vehicle was equipped with one of four unique device packages which provide a series of data elements which communicate the vehicle's location and motion. The packages are referenced as the Integrated Safety Device (ISD); Aftermarket Safety Device (ASD); Retrofit Safety Device (RSD) and Vehicle Awareness Device (VAD). More than 75 percent of the total equipped vehicles used a VAD, which is the most primitive device. Vehicles with VAD can only transmit the data being generated and collected by their host vehicle; they are not able to receive messages transmitted from other vehicles. They mainly transmit "here I am" messages while increasing the likelihood of vehicle-to-Vehicle (V2V) and vehicle-to-infrastructure (V2I) interactions. More detailed vehicle-based data came from vehicles equipped with ISD, ASD, and RSD packages with the ability to collect, receive and transmit. Those vehicles had more advanced safety features and they also collected video data files.

The Basic Safety Message (BSM) dataset contains BSMs that were sent and received by participating vehicles and roadside equipment. BSMs are part of the Society of Automotive Engineers (SAE) J2735 Standard. Every BSM contains Part I, the binary large object (blob) with data elements describing a vehicle's position (latitude, longitude, elevation) and motion (heading, speed, acceleration). Part II of a BSM contains optional data transmitted when required or in response to an event. Part II serves as an extension of vehicle safety information (path history, path prediction, event flags) and data that pertains to vehicle components such as lights, wipers, and brakes.

The proposed layout of the test site and the location of the roadside equipment capable of communicating via Dedicated Short Range Communication (DSRC) is below:
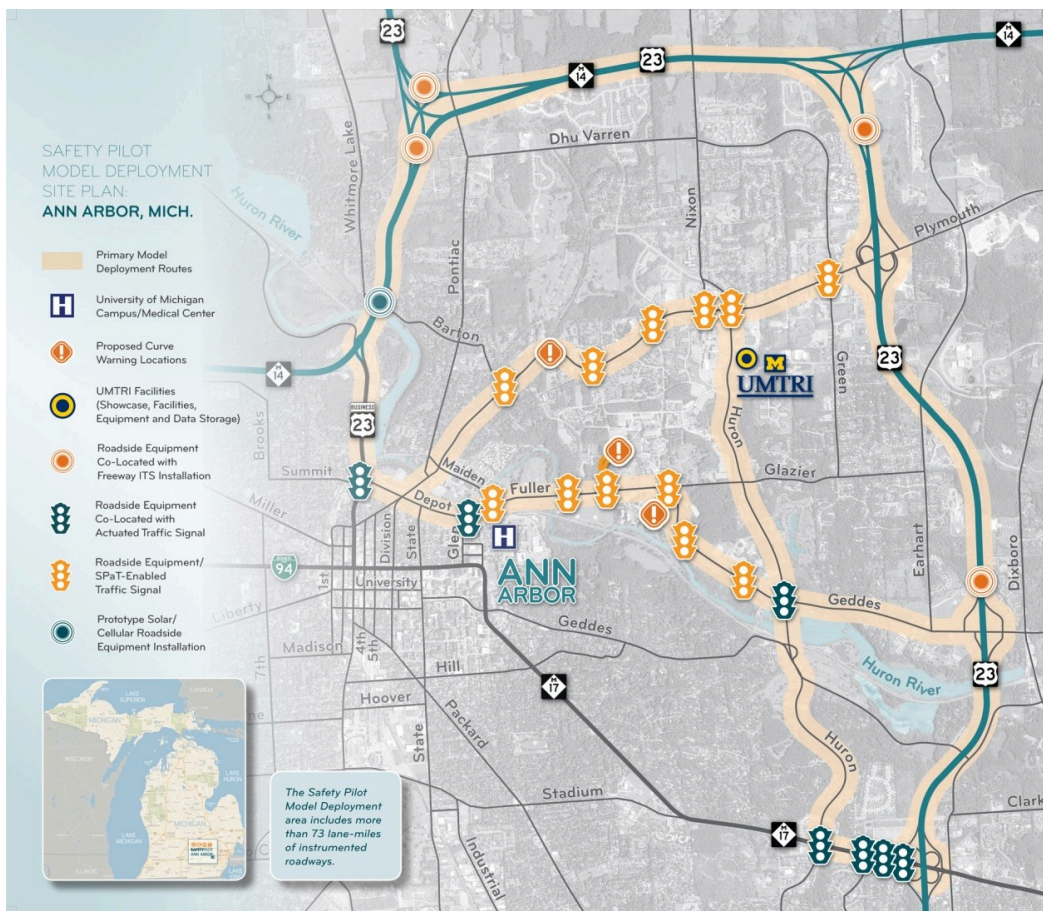
Citation for SPMD:
Bezzina, D., & Sayer, J. (2015, June). *Safety pilot model deployment: Test conductor team report* (Report No. DOT HS 812 171). Washington, DC: National Highway Traffic Safety Administration.

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THE PRIMARY J2735 BRAKE STATUS EVENTS VARIABLES

BrakeByte1Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

BrakeByte1Events J2735 Brake Status (primary)	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the brake system per J2735 standard: the first four bits are 0 or 1 for not-applied or applied respectivey for left front, right front, left rear, and right rear, in order; the fifth bit is one if brake information is unavailable; the sixth bit is unused and set to 0; and the last two bits represent the status of the Traction Control System (00=unavailable, 01=off, 10=on, 11=engaged)	N/A	N/A	N/A	No Special Values

THE MISCELLANEOUS BRAKE STATUS EVENTS VARIABLES

BrakeByte2Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

BrakeByte2Events J2735 Brake Status (miscellaneous)	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the brake system: the first two bits represent the status of the Antilock Brake System (00=unavailable, 01=off, 10=on, 11=engaged); the third and fourth bits represent the status of the Stability Control Unit (00=unavailable, 01=off, 10=on); the fifth and sixth bits represent the status of BrakeBoost (00=unavailable, 01=off, 10=on); and the last two bits represent the status of the Auxiliary (parking) Brake (00=unavailable, 01=off, 10=on)	N/A	N/A	N/A	No Special Values

THE BASIC SAFETY MESSAGE UNUSUAL EVENT FLAG VARIABLES

BsmEventFlag Event Flag	Count	Percent	Code	Value/Description
SAS Name: EventFlag Indicates 1 of 13 unusual events that have occurred	N/A	N/A	0	Hazard lights activated
	N/A	N/A	1	A vehicle anticipates passing the stop line at an intersection without coming to a full stop before reaching it
	N/A	N/A	2	Anti-locking braking system activated for more than 100ms in duration and active
	N/A	N/A	4	Traction control system activated for more than 100ms in duration and active
	N/A	N/A	8	Stability control system activated for more than 100ms in duration and active
	N/A	N/A	16	The vehicle is known to be carrying hazardous material and is placarded as such
	N/A	N/A	32	An authorized public safety vehicle is engaged in a service call and is currently moving (lights and sirens may not be evident)
	N/A	N/A	64	The vehicle has decelerated or is decelerating at a rate of greater than 0.4g
	N/A	N/A	128	The external lighting (headlights, park lights) of the vehicle has changed recently
	N/A	N/A	256	Status of the front of rear wipers of the vehicle has changed recently
	N/A	N/A	512	The vehicle has determined that at least one tire has run flat
	N/A	N/A	1024	Vehicle declaring itself as a disabled vehicle
	N/A	N/A	4096	At least one airbag has been deployed

THE BASIC SAFETY MESSAGE HIGHLY-DYNAMIC VARIABLES VARIABLES

BsmP1 Time of Basic Safety Message Generation	Count	Percent	Code	Value/Description
SAS Name: GenTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

BsmP1 Transmitting Device ID (Randomized)	Count	Percent	Code	Value/Description
SAS Name: TxRandom Randomly assigned ID to mask the device ID of the transmitting device for security purposes	N/A	N/A	N/A	No Special Values

BsmP1 Message Count	Count	Percent	Code	Value/Description
SAS Name: MsgCount Message ID that gets incremented by one with each BSM Minimum: 0	N/A	N/A	N/A	No Special Values

BsmP1 Deciseconds Since Ignition	Count	Percent	Code	Value/Description
SAS Name: DSecond Time in deciseconds since ignition started Minimum: 0	N/A	N/A	N/A	No Special Values

BsmP1 Latitude	Count	Percent	Code	Value/Description
SAS Name: Latitude Current latitude of the vehicle Minimum: -90 Maximum: 90	N/A	N/A	N/A	No Special Values

BsmP1 Longitude	Count	Percent	Code	Value/Description
SAS Name: Longitude Current longitude of the vehicle Minimum: -180 Maximum: 180	N/A	N/A	N/A	No Special Values

BsmP1 Elevation	Count	Percent	Code	Value/Description
SAS Name: Elevation Current elevation (in meters) of vehicle according to GPS	N/A	N/A	N/A	No Special Values

BsmP1 Speed	Count	Percent	Code	Value/Description
SAS Name: Speed Vehicle speed Minimum: 0	N/A	N/A	N/A	No Special Values

BsmP1 Heading	Count	Percent	Code	Value/Description
SAS Name: Heading Vehicle heading/direction Minimum: 0 Maximum: 360	N/A	N/A	N/A	No Special Values

BsmP1 Longitudinal Acceleration	Count	Percent	Code	Value/Description
SAS Name: Ax Longitudinal acceleration	N/A	N/A	N/A	No Special Values

BsmP1 Lateral Acceleration	Count	Percent	Code	Value/Description
SAS Name: Ay Lateral acceleration	N/A	N/A	N/A	No Special Values

BsmP1 Vertical Acceleration	Count	Percent	Code	Value/Description
SAS Name: Az "Vertical" acceleration	N/A	N/A	N/A	No Special Values

BsmP1 Yaw Rate	Count	Percent	Code	Value/Description
SAS Name: Yawrate Vehicle yaw rate	N/A	N/A	N/A	No Special Values

THE BASIC SAFETY MESSAGE HIGHLY-DYNAMIC VARIABLES VARIABLES

BsmP1 Path Count	Count	Percent	Code	Value/Description
SAS Name: PathCount Number, between 1 and 23, representing a group of points that communicate a vehicle's position and motion. Each group of points is of non-uniform size. Minimum: 0 Maximum: 23	N/A	N/A	N/A	No Special Values

BsmP1 Radius Of Curve	Count	Percent	Code	Value/Description
SAS Name: RadiusOfCurve Estimate of the radius of a curve being negotiated (in centimeters), which is derived from a number of systems and sensors. Positive and negative values reflect right and left turns, respectively, and +/- 32767 for straight paths. Minimum: -32767 Maximum: 32767	N/A	N/A	N/A	No Special Values

BsmP1 Confidence	Count	Percent	Code	Value/Description
SAS Name: Confidence Signals the accuracy and non-steady state and steady state of curvature estimate. In steady state (straight roadways or curves with constant radius of curvature), a high confidence value is reported. Minimum: 0 Maximum: 100	N/A	N/A	N/A	No Special Values

THE EXTERIOR LIGHTS EVENTS VARIABLES

ExteriorLightsEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

ExteriorLightsEvents Light Status	Count	Percent	Code	Value/Description
SAS Name: Value Describes the states of the nine exterior lights via an 8-bit string: each bit from left to right is 1 or 0 for on and off respectively, corresponding to, in order, parking lights, fog lights, daytime running lights, automatic lights, right turn signal, left turn signal, high beam headlights, and low beam headlights; bits 5 and 6 (right and left turn signal respectively) both being on signifies hazard lights	N/A	N/A	N/A	No Special Values

THE POSITIONAL ACCURACY RELATIVE TO SEMI-MAJOR AXIS VARIABLES

PosAccurByte1Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte1Events Axial Quality Measure	Count	Percent	Code	Value/Description
SAS Name: Value Quality measure, reflecting the positional accuracy with respect to the semi-major axis	N/A	N/A	254	12.7 meters or more
	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY RELATIVE TO SEMI-MINOR AXIS VARIABLES

PosAccurByte2Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte2Events Axial Quality Measure	Count	Percent	Code	Value/Description
SAS Name: Value Quality measure, reflecting the positional accuracy with respect to the semi-minor axis	N/A	N/A	254	12.7 meters or more
	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY SEMI-MAJOR AXIS ORIENTATION MOST SIGNIFICANT BYTE VARIABLES

PosAccurByte3Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte3Events Semi-Major Axis Orientation	Count	Percent	Code	Value/Description
SAS Name: Value Orientation measure of semi-major axis relative to true north (use in conjunction with PosAccurByte4Events.Value — AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479; only "unavailable accuracy" if both values equal to 255)	N/A	N/A	255	unavailable accuracy

THE POSITIONAL ACCURACY SEMI-MAJOR AXIS ORIENTATION LEAST SIGNIFICANT BYTE VARIABLES

PosAccurByte4Events End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

PosAccurByte4Events Semi-Major Axis Orientation	Count	Percent	Code	Value/Description
SAS Name: Value Orientation measure of semi-major axis relative to true north (use in conjunction with PosAccurByte3Events.Value — AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479; only "unavailable accuracy" if both values equal to 255)	N/A	N/A	255	unavailable accuracy

THE STEERING WHEEL ANGLE EVENTS VARIABLES

SteerAngleEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

SteerAngleEvents Steering Wheel Angle	Count	Percent	Code	Value/Description
SAS Name: Value	N/A	N/A	126	189 degrees or more
to be converted to degrees to	N/A	N/A	127	unavailable steering angle
communicate steer angle	N/A	N/A	128	-189 degrees or more

THE THROTTLE POSITION EVENTS VARIABLES

ThrottlePositionEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

ThrottlePositionEvents Relative Throttle Position	Count	Percent	Code	Value/Description
SAS Name: Value Details the relative position of the throttle over a given trip	N/A	N/A	N/A	No Special Values

THE TRANSMISSION STATE EVENTS VARIABLES

TransStateEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

TransStateEvents Transmission State	Count	Percent	Code	Value/Description
SAS Name: Value Details the current state of specific components of the transmission	N/A	N/A	0	Transmission is in the neutral position
	N/A	N/A	1	Transmission is in the park position
	N/A	N/A	2	Transmission has engaged one of its forward gears
	N/A	N/A	3	Transmission has engaged one of its reverse gears
	N/A	N/A	4	Reserved for future use
	N/A	N/A	5	Reserved for future use
	N/A	N/A	6	Reserved for future use
	N/A	N/A	7	Unavailable value or not equipped with a transmission

THE VEHICLE LENGTH EVENTS VARIABLES

VehicleLengthEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

VehicleLengthEvents Vehicle Length	Count	Percent	Code	Value/Description
SAS Name: Value Details the length of the vehicle	N/A	N/A	N/A	No Special Values

THE VEHICLE WIDTH EVENTS VARIABLES

VehicleWidthEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

VehicleWidthEvents Vehicle Width	Count	Percent	Code	Value/Description
SAS Name: Value Details the width of the vehicle	N/A	N/A	N/A	No Special Values

THE FRONT WINDSHIELD WIPER STATUS EVENTS VARIABLES

WiperStatusFrontEvents End Time	Count	Percent	Code	Value/Description
SAS Name: EndTime A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security	N/A	N/A	N/A	No Special Values

WiperStatusFront Wiper Status	Count	Percent	Code	Value/Description
SAS Name: Value Length of vehicle	N/A	N/A	0	Unavailable
	N/A	N/A	1	Off
	N/A	N/A	2	Intermittent
	N/A	N/A	3	Low
	N/A	N/A	4	High
	N/A	N/A	126	Washer In Use
	N/A	N/A	127	Automatic Washer Equipped