

Specification

AI Mobility Platform

This specification defines the minimum requirements for an AI mobility platform (“Platform”) that provides non-intrusive detection of traffic at signalized intersections using hybrid sensors that fuse video and radar, a cloud portal, 24/7 live monitoring & support, remote connectivity, and a variety of ITS applications for stop bar, advance, dilemma, bicycle, and pedestrian detection, traffic counts, real-time optimization, signal performance measures, and safety analytics.

1 Hardware

1.1 General

The Platform shall comprise two primary hardware components, the Sensor and the cabinet interface unit (“Nexus”).

All hardware and material shall be new. All fasteners exposed to the elements shall be Type 304 or Type 316 passivated stainless steel. Primary hardware components shall have permanent labels that bear the name of the manufacturer, description, part number, date of manufacture, and serial number.

All hardware shall comply with the environmental and operating requirements of NEMA TS 2 Section 2.1.5 (Temperature & Humidity), Section 2.1.6 (Transients, Power Service), Section 2.1.8 (Nondestructive Transient Immunity), Section 2.1.9 (Vibration), and Section 2.1.10 (Shock) and shall have been tested by an independent third-party laboratory using the procedures defined in Section 2.2.7 (Transients, Temperature, Voltage, and Humidity), Section 2.2.8 (Vibration), and Section 2.2.9 (Shock/Impact).

1.2 Sensor

The Sensor shall comprise a video sensor and a radar sensor housed in a single enclosure that mounts on traffic signal structures (mast arms, strain poles, posts, etc.). The Platform shall be supplied with one Sensor per approach including at least one Sensor Type 2 and the remainder Sensor Type 1, or in quantities specified by the contract documents.

Sensor Type 1 shall include a 1080p HD video camera, 60 GHz radar, Nvidia processor, one 8P8C Ethernet receptacle, and Wi-Fi communications. Sensors employing radar frequencies such as 24 GHz that are susceptible to interference from 5G communications are not compliant with this specification.

Sensor Type 2 shall comprise Sensor Type 1 plus a C-V2X module and two external omnidirectional V2X antennas. Sensor Type 2 shall comply with FCC regulations for C-V2X roadside units (RSUs).

Sensor enclosures shall be rated for IP67 and MIL-STD-810G. Sensors shall operate over a nominal input voltage range of 89 to 264 VAC at 50 or 60 Hz and shall have three internal terminals for the line, neutral, and ground conductors of standard, off-the-shelf power cable such as IMSA signal cable. Sensors that require proprietary power cable are not compliant with this specification. Sensors shall be powered from the transportation field cabinet or from street light luminaires as specified by the contract documents.

1.3 Nexus

The Nexus shall consist of a ruggedized, field hardened computing device that mounts in and interfaces with transportation field cabinets. The Platform shall be supplied with one Nexus per intersection or in quantities specified by the contract documents. Nexus units shall support up to 10 Sensors per intersection in any combination of Sensor Type 1 and Sensor Type 2.

Nexus units shall include an Nvidia processor, two 8P8C Ethernet receptacles, Wi-Fi communications, one DA-15 synchronous serial communications port conformant to NEMA TS 2 Section 3.3.1 (Port 1 Physical and Protocol), and a front panel menu-driven user interface with a backlit display and navigation buttons.

The Nexus shall interoperate with NEMA TS 1, NEMA TS 2, Model 33x, ITS, and ATC transportation field cabinets and support the NEMA TS 2 and ITS/ATC cabinet synchronous serial bus protocols. It shall be capable of logging all communications on the synchronous serial bus including frames transmitted by other secondary stations, detect the cabinet I/O protocol currently in use (TS 2 or ITS/ATC) in order to automatically configure the synchronous serial port, and detect any other I/O interface units (BIUs or SIUs) currently in use in order to prevent duplicate synchronous serial bus address assignments.

1.4 Auxiliary Components

1.4.1 Nexus Power & Communications Assembly

The Nexus Power & Communications Assembly shall reside in the transportation field cabinet. It shall comprise a DIN rail to which the following components are mounted:

- Terminal blocks for utility power
- Power supply for Nexus
- Cellular modem
- Firewall router

The cellular modem shall be capable of switching between all major mobile network operators without changing the SIM card.

1.4.2 Sensor Power Assembly

The Sensor Power Assembly shall reside in the transportation field cabinet to protect and condition power for either 4 or 6 Sensors. It shall comprise a DIN rail to which the following components are mounted:

- Terminal blocks
- Surge suppressor
- Circuit breakers
- Web relay

1.4.3 Antenna

The Antenna shall facilitate all wireless communications at the transportation field cabinet, including Wi-Fi, cellular, and GPS. It shall comprise nine antennas housed in a single IP67 enclosure that creates a weathertight seal when mounted to the transportation field cabinet, and nine cables terminated with SMA male connectors.

2 Software

2.1 Embedded Software

Embedded software shall support over-the-air (OTA) updates.

2.2 Nexus User Interface

Nexus units shall provide a browser user interface for viewing real-time data, viewing historical data, and editing configuration data. The browser user interface shall be compatible with the current versions of browsers based on the WebKit (Safari), Blink (Chrome, Edge), and Gecko (Firefox) rendering engines. Access to the Nexus browser user interface shall be restricted to designated users using username and password authentication.

2.3 Mobility OS

The Platform shall include a cloud portal ("Mobility OS"). Mobility OS shall be hosted on AWS in the US or Canada using discrete servers for each infrastructure owner/operator (IOO). The IOO's server shall not contain any other IOO's data, and none of the IOO's data shall reside on any other IOO's server. Cloud portals that combine data from multiple IOOs on a single server are not compliant with this specification.

Mobility OS shall provide a browser user interface for viewing real-time data, viewing historical data, and editing configuration data. The browser user interface shall be compatible with the current versions of browsers based on the WebKit (Safari), Blink (Chrome, Edge), and Gecko (Firefox) rendering engines.

Access to Mobility OS shall be restricted to designed users using username and password authentication. Mobility OS shall support single sign on (SSO) from the IOO's directory.

The Platform shall include Mobility OS for five years or for the term otherwise specified by the contract documents.

2.4 Communications

All data transmitted by the Platform between Sensors, Nexus units, and Mobility OS shall occur over virtual private networks (VPNs) using AES-256 encryption. Wi-Fi communications shall employ WPA2-AES security. Sensor-Nexus communications shall use Wi-Fi or Ethernet as specified by the contract documents.

3 Functionality

3.1 Detection

The Platform shall detect the passage and presence of traffic in zones located between 30 ft and 720 ft from the Sensors and report the occupancy of each zone via inputs of transportation field cabinets. It shall be possible to associate each detection zone with one or more inputs, and it shall be possible to associate multiple detection zones with the same input. When a detection zone is occupied by traffic of the selected characteristics (class, speed, etc.), it shall be considered actuated, and its inputs shall be ON; otherwise, its inputs shall be OFF.

The Platform shall support the full input functionality of NEMA TS 1, NEMA TS 2, Model 33x, ITS, and ATC transportation field cabinets, such that inputs can be mapped in actuated signal controllers to detectors, programmable logic, or any other input function supported by the controller.

To minimize Sensor–Nexus communications, all processing required to detect, classify, and track objects shall occur in the Sensor.

Detection accuracy shall be at least 98% under typical environmental conditions, where “detection accuracy” is time with no false calls or missed calls versus total time, expressed as a percentage. The Platform’s detection accuracy shall have been evaluated at a minimum of six traffic control signals, each owned and operated by a different IOO on roadways open to the public. Evaluations performed at test beds, closed tracks, academic institutions, research laboratories, signal maintenance shops, and other such facilities and environments not open to public travel shall not be used to satisfy this requirement. Upon request, the Manufacturer shall provide engineering reports for the evaluations that include descriptions of their methodologies and results. The reports shall be attested by a licensed Professional Engineer employed by the Manufacturer.

3.1.1 Sensor Fusion

The Sensor shall fuse video and radar, continually evaluating and comparing video and radar data to achieve optimal detection for the current environmental conditions, traffic, and detection zones. Detection shall not be affected by a loss of either video alone or radar alone, whether due to environmental conditions, malfunctions, or otherwise. Platforms with separate video detection zones and radar detection zones or those that otherwise treat

video and radar as independent, non-fused sensors are not compliant with this specification.

3.1.2 Classification

The Platform shall classify each object as an automobile, truck, bus, motorcycle, bicycle, or pedestrian.

3.1.3 Tracking

The Platform shall track the position (lane, phase, and distance to stop line) and trajectory (direction and speed) of each object.

3.1.4 Intelligent False Call Rejection

The Platform shall not actuate detection zones occupied by vehicles that are not moving with the prevailing flow of traffic, including vehicles that are performing road work, disabled, or illegally parked. This functionality prevents these vehicles from registering demand and unnecessarily calling or extending phases.

3.1.5 Failsafe Operation

Upon any anomaly that affects its ability to provide accurate detection, including but not limited to hardware or communications failures, the Platform shall default to a safe condition via constant calls or other mechanism supported by the transportation field cabinet.

3.2 V2X

The Platform shall support connected vehicle applications and connected intersection operation in accordance with relevant industry standards and guidelines including CTI 4001, CTI 4501, J2735, J2745, NTCIP 1202, and NTCIP 1218. It shall be capable of generating SPAT data for all makes and models of actuated signal controllers and transportation field cabinets, including those without built-in SPAT or TSCBM generation capabilities, and SDSMs for non-connected road users per SAE J3224.

3.3 Turning Movement Counts

The Platform shall detect maneuvers made by traffic at the intersection (“Turning Movement Counts”) and classify them as right turns, through movements, left turns, U-turns, and

pedestrian crossings. Turning Movement Counts shall be generated automatically upon installation of the Platform from object detection rather than detection zone actuations so as not to require setup or configuration of detection zones specifically for counts.

Turning Movement Counts shall be uploaded to Mobility OS. A graphical user interface (GUI) for retrieval and analysis of Turning Movement Counts shall be provided in Mobility OS. The GUI shall support filtering Turning Movement Counts by date/time for either a single period or two periods (for side-by-side comparisons), by maneuver (left, through, right, etc.), by class (car, truck, bus, etc.), and by approach. The GUI shall support downloads of Turning Movement Counts in CSV and PDF formats aggregated in 15 minute, 1 hour, and 1 day bins.

3.4 Dilemma Zone Detection

The Platform shall detect vehicles in the dilemma zone (“Dilemma Zone Detection”). Dilemma Zone Detection shall be implemented via Dilemma Detection Zones, where a Dilemma Detection Zone has a user-defined location (upstream and downstream distances from the stop line), speed range, and extension time. Each Dilemma Detection Zone shall be capable of being associated with one or more inputs in the transportation field cabinet.

When a vehicle enters a Dilemma Detection Zone and the speed of the vehicle is within the range of speeds for said Dilemma Detection Zone, the Platform shall actuate the inputs associated with the Dilemma Detection Zone for the associated extension time. By associating the inputs with extension detectors in the actuated signal controller, phases can be extended until vehicles are clear of the dilemma zone.

3.5 Pedestrian Protection

The Platform shall detect pedestrians in the crosswalk (“Ped Protection”). Ped Protection shall be implemented via Ped Protection Zones drawn over crosswalks. Each Ped Protection Zone shall be capable of being associated with one or more inputs in the transportation field cabinet.

The Platform shall actuate the inputs associated with the Ped Protection Zone when the zone is occupied by a pedestrian. By associating the inputs with detectors in the actuated signal controller, vehicle phases, pedestrian phases, and signal intervals can be extended, and custom logic can be implemented to enable other responses.

3.6 Automated Traffic Signal Performance Measures

The Platform shall provide automated traffic signal performance measures (ATSPMs). ATSPMs shall be generated automatically upon installation of the Platform from object detection rather than detection zone actuations so as not to require setup or configuration of detection zones specifically for ATSPMs.

ATSPMs shall be supported for all makes and models of actuated signal controllers and transportation field cabinets, including those that do not natively support high-resolution data logging. ATSPMs shall run in parallel with and not interfere with any third-party ATSPMs that use the high-resolution data logging facilities of the actuated signal controller.

A GUI for retrieval and analysis of ATSPMs shall be provided in Mobility OS. The GUI shall support filtering ATSPMs by date/time for either a single period or two periods (for side-by-side comparisons) and by classification (car, truck, bus, etc.). The GUI shall support downloads of ATSPMs in CSV and PDF formats.

The following ATSPMs shall be provided:

- Average vehicle delay
- Maximum vehicle delay
- Level of service
- Pedestrian delay
- Arrivals on green/red
- Level
- Purdue phase termination
- Split monitor
- Peak hour, peak hour factor, design hour factor, and directional factor

3.7 Incident Detection

The Platform shall detect incidents that disrupt the normal flow of traffic, including but not limited to crashes, road work, and disabled vehicles. A time-stamped log of incidents shall be available in Mobility OS, and the Platform shall provide notifications of incidents via Mobility OS, email, text, and/or phone call. The means of delivering notifications shall be user customizable per incident type.

3.8 Timing Optimization

The Platform shall provide real-time, distributed adaptive signal control (“Timing Optimization”). Timing Optimization shall be supported for all makes and models of actuated signal controllers and transportation field cabinets. Timing Optimization shall use data from object detection rather than detection zone actuations so as not to require setup or configuration of detection zones specifically for optimization.

Timing Optimization shall support a variety of intersection-level and corridor-level strategies including balanced delay reduction, progression, crossing arterial coordination, queue management during oversaturation, transit prioritization, pedestrian prioritization, maximal throughput, queue management on freeway off ramps, optimization of non-through movements, preemption recovery, and tightly spaced intersection management. Multiple strategies shall be capable of being in effect simultaneously. Cycle lengths shall be optimized and implemented on a per-Intersection basis so as not to require a common cycle length along the corridor.

A GUI for configuring, controlling, and monitoring Timing Optimization shall be provided in Mobility OS.

3.9 Red Light Running Analytics

The Platform shall collect and store data about vehicles that enter the intersection (cross the stop line) on yellow and red including classification (car, truck, or bus), movement, approach, signal interval (yellow change interval, red clearance interval, or red phase off interval), distance, speed, and time after yellow.

A GUI for retrieval and analysis of the data shall be provided in Mobility OS. The GUI shall provide side-by-side comparisons of data from two periods facilitating before/after comparisons, a variety of textual and graphical views, and video clips of each event.

3.10 Remote Controller Access

The Platform shall provide access in Mobility OS to the browser user interface of actuated signal controllers and all functionality thereof as implemented by the manufacturer of the actuated signal controller such as status monitoring, timing parameter editing, configuration load/save, and controller front panel emulation.

3.11 Streaming Video

The Platform shall provide high-definition RTSP video streams in H.264 AVC and H.265 HEVC encodings for each Sensor and a quad view that combines streams from four Sensors.

Detection zone boundaries (outlines) shall be displayed in the video streams using one of two colors depending on whether the zone is actuated.

Traffic signal state shall be displayed in the video streams using icons located on the downstream (intersection) side of the stop line at each approach lane. The color of the signal state icons shall reflect the state of the associated phase, and the icons shall be labeled with the phase number.

3.12 Cellular Connectivity

The Platform shall include cellular data for five years or for the term specified by the contract documents.

4 Service & Support

4.1 Live Monitoring

The Manufacturer shall provide live, continuously staffed 24/7 monitoring of the Platform for five years or the term specified by the contract documents. The Platform shall be monitored for abnormalities, anomalies, performance, reliability, faults, incidents, alarms, and severe weather events. Monitoring by personnel who are on call during personal time, performing other tasks, or otherwise not solely dedicated to monitoring is not compliant with this specification. Personnel shall be knowledgeable in the principles and practices of traffic engineering, traffic control devices, and traffic signal equipment.

4.2 Installation Support

The Manufacturer or their designated representative shall provide on-site turn-on assistance, Monday through Friday, with a minimum one-week advance notice.

4.3 Technical Support

The Manufacturer shall provide 24/7 technical support via email and telephone for five years or the term specified by the contract documents.

4.4 Documentation

The Manufacturer shall provide electronic manuals in PDF or HTML formats that include installation, configuration, operation, troubleshooting, and maintenance information.

4.5 Training

The Manufacturer shall provide a maximum of two virtual training sessions per IOO of a maximum of three hours per session. The sessions shall include installation, configuration, operation, troubleshooting, and maintenance information. Instructors shall be certified by the Manufacturer.

4.6 Software Updates

The Platform shall include updates to the embedded and cloud software for five years or the term specified by the contract documents.

5 Warranty

The Manufacturer shall warrant that all Manufacturer-supplied equipment and material is free from material and workmanship defects for five years or the term specified by the contract documents ("Hardware Warranty Period"). The Hardware Warranty Period shall start when the equipment is received by the IOO.

During the Hardware Warranty Period, the Manufacturer or their designated representative shall repair or replace, at no cost to the IOO, defective equipment and material. The Manufacturer or their designated representative shall maintain an adequate inventory of equipment and material to support warranty claims.

6 Manufacturer Certifications

The Manufacturer shall maintain SOC 2 Type II and ISO 27001 (Information Security Management) certifications and provide them on request.

7 Measurement and Payment

The Platform shall be measured in units of each and paid at the contract unit price per each. The price shall include furnishing and installing the following components:



- Three Sensor Type 1
- One Sensor Type 2
- One Nexus
- One Nexus Power & Communications Assembly
- One Sensor Power Assembly
- One Antenna

The price shall include all work required to test and confirm proper operation of the individual components and integrate them as a complete system.