Amendment 4A to the Addendum for the

Human Factors/Safety and Automated Vehicle Program

The following work plan covers the University of Iowa's (UI) support for the Human Factors/Safety and Automated Vehicle Program for the Iowa Department of Transportation (DOT). Dr. Dan McGehee, Director of the National Advanced Driving Simulator and a professor in the department of mechanical and industrial engineering, is designated as the Program Manager (PM).

All tasks will be assigned to the PM, Dr. Dan McGehee, and will be coordinated through Ms. Sandra Larson, Systems Operations Bureau Director for the Iowa DOT. These tasks may be modified during the year by mutual agreement between Dr. McGehee and Sandra Larson. The allocation of resources to support Iowa DOT programmatic needs will be re-evaluated periodically and annually. It is anticipated that others will be supported through this work plan, and will work at the direction of Dr. McGehee to complete the work plan tasks. All support staff, students or sub-consultants supported through this work plan will be identified and approved by the Iowa DOT.

All work performed through this work plan will be as directed and approved by the Iowa DOT. Progress made on the work plan tasks specifically detailed in Amendment 4 of the Addendum will be identified and detailed in the written program monthly progress reports. Updated work plans for additional and expanded efforts will be identified and submitted to Sandra Larson for Iowa DOT approval. The work plans also include proposed out-of-state travel to participate in meetings and conferences, subject to Iowa DOT approval and the availability of resources. Potential travel includes investigator and staff travel to project meetings in Chicago, Des Moines/Ames, meetings with potential vendors (anticipated Detroit area), possible meetings to the build site (Detroit or southern region) and planning for additional domestic travel that may present itself during the demonstration preparation phase.

The existing executed Management Agreement between the University of Iowa and the Iowa DOT will apply to this addendum.

Track 4A: Information for Humans – Hazard Alerting Data Feed Demonstration

The purpose of Track 4A is to test the flow of real-time information and showcase the ability to present HERE hazard alerting technology and live map into a vehicle. Hazard alerting presentation design will concentrate on creating minimally distracting displays of such data. UI human factors specialists will use their vast expertise in human-machine

interface (HMI) design to ensure that the information displayed can meet or exceed NHTSA distraction guidelines.

The UI proposes a vigorous and aggressive timeline for Track 4A, beginning with the finalization of the use cases to be demonstrated (as described in Task 1 below). The UI's projected timeline is based on a February 1, 2017 start date and is illustrated on Page 6 of this proposal.

Task 1: Finalization of the use cases

The Iowa DOT and project team (project team includes the Iowa DOT, HERE, UI, and ISU) will collaborate to determine two use cases and specific accompanying scenarios to be demonstrated. Use cases under consideration include: winter weather alerting, route incident information including construction and traffic alerting, as well as traffic flow and congestion information. Discussions with the Iowa DOT and project team will help to narrow these use cases and the applicable driving scenarios down to the two that will be used for the public demonstration as part of Task 5.

- Milestone: UI memo to Iowa DOT detailing the two Use Case determinations for the demonstration. Memo will note the collaborative and evaluative process utilized by the team to determine the use case to be demonstrated in 4A

Task 2: Design of the in-vehicle alerts

Upon finalization of the use cases by the project team, the UI will begin to design the renderings that will be displayed by the in-dash alerting system in an UI instrumented vehicle. The renderings will be designed and developed by the UI in accordance with human factors guidelines for the design and display of in-vehicle information as well as the NHTSA distraction guidelines. For example, general design guidelines regarding symbol legibility, use of color/contrast and message styles will be examined. In addition, specific considerations will be made regarding the content, timing and modality (e.g., auditory alerts) for presenting in-vehicle information and alerts. The UI will share draft rendering of the interface to facilitate feedback and input by project stakeholders, including Iowa DOT. These renderings will be revised based on feedback. The main deliverable for this task will be the finalized renderings of the in-vehicle alerts. These renderings will be programmed and integrated into the vehicle in subsequent tasks.

- Deliverable: Draft Renderings
- Deliverable: Finalized Renderings

Task 3: Integration with the HERE API

This task is primarily a software engineering activity. The goal will be to connect the UI instrumented vehicle software with the HERE Cloud using the HERE API (application programming interface) that has been provided to the UI. This task will culminate in a successful bench test that shows a connection with the HERE cloud. The UI will demonstrate the ability to display a hazard alert that is initiated through a trusted source, delivered to the cloud, and communicated to the UI's software using the HERE API. In this

task, placeholder symbols will be used (or draft renderings from Task 2, if available) for warnings. The finalized renderings will be integrated in Task 4. Task 3 will include determining the ability to issue warnings from the cloud to enable testing. This will require coordination with HERE and/or Iowa DOT. It should be noted that this task has the added benefit of demonstrating that the HERE cloud has the capability of being used by 3rd party software.

- Deliverable: Memo to Iowa DOT confirming that the bench test has been completed and successful

Task 4: Complete Development and Integration of all Hardware and Software into the UI instrumented vehicle

In Task 4, the UI will design, create and program the interface to display the in-vehicle alerts that were designed in Task 2. The interface software will be integrated with the UI instrumented vehicle software from Task 3. UI, HERE and Iowa DOT will discuss the possible implementation of additional operational details that may provide a system that is easy to use, reliable and efficient in supporting on-road demos, including, but not limited to, alerts issued by the TMC, HERE or other State of Iowa entity. The UI will also enhance what has been developed in Task 3, to communicate with the cloud via a cellular connection since this system has to work in a moving on-road vehicle. The UI will need to potentially enhance software to address bandwidth related issues with the cell service.

The Iowa DOT can visit the UI facility at any time and experience the in-vehicle demonstrations on the road. Iowa DOT and UI will work together to enhance Iowa DOT's capability to remotely experience and view the on-road demonstrations via a link at the Iowa DOT. Iowa DOT and UI will also work together to facilitate a mechanism that allows many more people to experience these demonstrations via a live link, at any time, from the Iowa DOT TMC. Iowa DOT and UI agree to utilize Innovative Software Engineering (ISE), an Iowa-based small business to achieve this goal, ISE's involvement will also in itself serve to demonstrate that 3rd parties are able to utilize state-wide cloud based services.

Part way through this task, the UI will invite the Iowa DOT for a site visit to demonstrate limited functionality of this system. The UI will conduct several tests to ensure proper and safe function of the software in the instrumented vehicle. UI will coordinate with the Iowa DOT and HERE to perform pre-demonstration tests of the hazard alerts.

- Milestone: UI invites the Iowa DOT to NADS for a site visit to demonstrate the functionality of the full integration
- Milestone: Pre-demonstration tests of the hazard alerting demonstration to be conducted

Task 5: Public Demonstration of the Hazard Alerting Data Feed capability (marketing demonstration - what it means for Iowans)

In this task, the UI will work with the Iowa DOT and HERE to develop the overall marketing demonstration outreach announcement and planned demonstration. This will include the

date of the demonstration, setting, time, and how the demonstration will be communicated to the public in the form of press releases, short videos (for social media), longer videos (for YouTube), infographics, and the public messaging to be used for the demonstration. This will require coordination between the UI, Iowa DOT, and HERE. The Iowa DOT will advise if they prefer to have a media company responsible for the outreach or if it will be completed through the project team communication lines. Additionally, the marketing plans will detail the number of days the demonstrations will be open to the media. The Iowa DOT will approve all components of the demonstrations.

- Milestone: Completed Demonstration

Task 6: 4A Final Reporting

In this task, the UI will deliver a 4A Final Report that fully details Tasks 1 – 5, including any changes or updates that were made during the process. The Final Report will include the entire Hazard Alerting Demonstration process undertaken by the team as well as the results of the demonstrations (how they were publicized, time, place, setting, attendees, comments from public and stakeholders). Additionally, the Final Report will include the lessons learned from the initial demonstration and propose the Future Hazard Alerting Demonstration possibilities. Demonstration possibilities include, but are not limited to: a winter weather alerting demonstration, a construction and traffic alerting demonstration, connected infrastructure communication from traffic signals to the vehicle or the HERE cloud (UI will collaborate directly with CTRE and the Iowa DOT on the traffic signal technologies), and any other possibilities determined and discussed during Amendment 4. The UI will document all possibilities and submit a demonstration proposal to the Iowa DOT.

Figure 1: UI's Instrumented on-road vehicle. The 2012 Toyota Camry features a fully instrumented vehicle to record audio, video, eye-tracking, and drive data. All instrumentation is concealed to make the vehicle appear similarly to a production vehicle.

- Deliverable: 4A Hazard Alerting Demonstration Final Report

Assumptions

The UI's Amendment 4A is operating under the assumptions listed below. Upon receiving further information and finalization of the Vision Document prepared by HERE and the overall timeline, the UI will amend the deliverables to fit the updated needs identified by the Iowa DOT. If these assumptions are not met, the UI's tasks, deliverables, and milestones under 4A may require re-adjustment and scoping to best meet the project

needs. Each monthly progress report will detail the progress towards all milestones and deliverables and include feedback if the project assumptions progress differently than noted below and their effect on the overall project.

- Assumption 1: HERE map data will be available to support navigation and highly automated driving. The HERE API (or other software provided by them) will enable us to receive hazard alerts via the cloud.

- Assumption 2: HERE map data will contain enough resolution (a minimum of 20 cm with 100 meter ahead in real-time) and lane information to support highly automated driving scenarios

- Assumption 3: HERE will work with the systems vendor that UI selects and provide support for integration of the map and cloud data with the vendor's vehicle system

- Assumption 4: Pinpoint GPS infrastructure, via access to Iowa DOT's RTK (Real Time Kinematic) network, will be available to guide a vehicle on the High Definition map.

- Assumption 5: Iowa DOT will approve the overall testing and demonstration plans.

- Assumption 6: In order to meet a Fall 2017 deadline for the initial demonstration, the UI will have to initiate the build order for the vehicle by end of January 2017.

- Assumption 7: 4A Task 3 and Task 4 reflect the work associated with connecting the UI instrumented vehicle software to the HERE cloud using the API that HERE has provided. These tasks do not involve the integration with other HERE technologies including their mobile application.