

Plan Overview

A Data Management Plan created using DMP Tool

DMP ID: <https://doi.org/10.48321/D16F3FD7E1>

Title: Perception-Based Adaptive Traffic Management and Data Sharing

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Affiliation: United States Department of Transportation (DOT) ([transportation.gov](https://www.transportation.gov))

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Project Administrator: Zoami Sosa

Funder: United States Department of Transportation (DOT) ([transportation.gov](https://www.transportation.gov))

Funding opportunity number: DOT-SMART-FY23-01

Grant: 69A3552341025 SMARTFY22N1P1G13

Template: SMART Grants Stage 1 Data Management Plan (DMP)

Project abstract:

Plan, prototype, and test a multi-dimensional Perception-Based Adaptive Traffic Management and Data Sharing system in the Pikes Peak Region, partnering with academia, industry, and the National Renewable Energy Laboratory (NREL).

Start date: 08-15-2023

End date: 02-15-2025

Last modified: 06-05-2025

Copyright information:

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Perception-Based Adaptive Traffic Management and Data Sharing

Dataset and Contact Information

Please provide as much of the the following information as possible:

1. Name of the project;
2. Grant number;
3. Name of the person submitting this DMP;
4. ORCID of the person submitting this DMP (need an ORCID? Register here: <https://orcid.org/>);
5. Email and phone number of the person submitting this DMP;
6. Name of the organization for which the person submitting this DMP is working;
7. Email and phone number for the organization;
8. Link to organization or project website, if applicable; and,
9. Date the DMP was written.

1. Name of the project: Perception-Based Adaptive Traffic Management and Data Sharing
2. Grant number: 69A3552341025 SMARTFY22N1P1G13
3. Name of the person submitting this DMP: Daniel Sines
4. ORCID of the person submitting this DMP: N/A
5. Email and phone number of the person submitting this DMP: dan.sines@coloradosprings.gov, (719) 641-5654
6. Name of the organization for which the person submitting this DMP is working: City of Colorado Springs, Traffic Engineering
7. Email and phone number for the organization: (719) 385-5908
8. Link to organization or project website: coloradosprings.gov
9. Date the DMP was written: Dec 15, 2023
10. Date the DMP was revised: June 5, 2025

Data Description

Please provide as much information as possible:

1. Provide a description of the data that you will be gathering in the course of your project or data from a third party that you will re-use, if any;
 1. If there will be no data collected or re-used from another source, state that this is case;
2. Address the expected nature, scope, and scale of the data that will be collected, as best as you can at this stage;
3. As best as you can, describe the characteristics of the data, their relationship to other data, and provide sufficient detail so that reviewers will understand any disclosure risks that may apply;
 1. If data might be sensitive, please describe how you will protect privacy and security, if you know that now;
 2. You may need to update your DMP later to add more detail;
4. Discuss the expected value of the data over the long-term.

1. Description of the data:

- a. Vehicle tracking data from 3D perception sensors (radar, LiDAR and video analytic), including relative position, vector of travel, and size and/or classification
 - b. Efficiency metrics for adaptive methods of traffic signal control
 - c. Vehicle tracking data from V2X system, including GPS coordinates, vector of travel, classification/identity, and state/status
2. Nature, scope, and scale of the data
 - a. 3D perception, vehicle tracking data collected from up to 12 different sensors, deployed at four different intersections over multiple days. Given per vehicle updates every 50ms, the raw data set is hundreds of megabytes
 - b. Efficiency metrics for each adaptive method charted for inclusion in implementation report
 - c. V2X tracking data was collected from two different vehicles traveling along multiple corridors. Personal vehicles were utilized during this testing effort, and included a great deal of person travel habits, including overnight parking at personal residences. Therefore, we determined the datasets included to much personally identifying information, and should not be published. Evaluation conclusions are included in the implementation report.
 3. Characteristics of the data, their relationship to other data, and disclosure risks
 - a. 3D perception data was used by NREL as real-world data for further testing and evaluation of their data fusion engine, used to create a digital-twin of all participants approaching, within and leaving a signalized intersection; there are no disclosure risks because the data only represent movement characteristics and general classifications (e.g., passenger car, pedestrian, cyclist, etc.)
 - b. Efficiency metrics are based on simulations that utilized real-world data; there are no disclosure risks
 - c. V2X tracking data will be used to assess usefulness for emergency vehicle preemption and transit priority based on accuracy and overall system latency; normally, there are no disclosure risks, but because we utilized personally owned vehicles, the tracking data revealed personal residences.
 4. Expected value of the data over the long-term
 - a. Quality and latency of data was evaluated to set performance expectations for systems that utilize the data for reactions in real-time, plus post-analysis performance measurements
 - b. Comparison of efficiencies for different adaptive methods was used to determine scenarios where they outperform each other and other traditional traffic management methods
 - c. Quality and latency of data was evaluated to set performance expectations for real-time preemption implementation

Data Format and Metadata Standards Employed

Please provide as much information as you can:

1. Describe the anticipated file formats of your data and related files;
 2. To the maximum extent practicable, your DMP should address how you will use platform-independent and non-proprietary formats to ensure maximum utility of the data in the future;
 1. If you are unable to use platform-independent and non-proprietary formats, you should specify the standards and formats that will be used and the rationale for using those standards and formats.
 3. Identify the metadata standards you will use to describe the data.
 1. At least one metadata file should be a DCAT-US v1.1 (<https://resources.data.gov/resources/dcat-us/>) .JSON file, the federal standard for data search and discovery.
1. Anticipated file formats of your data and related files
 - a. Thus far, data formats for perception sensors have been proprietary binary structures, CSV files, JSON files and XML files, as dictated by each sensor manufacturer or point-cloud processing software package. Cooperating with manufacturers (Wavetronix and InnoSenT), the City of Colorado Springs created software to convert

- proprietary binary structures to CSV files. NREL is working with the City of Colorado Springs and other stakeholders to develop a standard data set, format and transport method for the digital-twin data that is output by their fusion engine
 - b. Charted efficiency metrics have been graphical images incorporated into the implementation report
 - c. V2X Basic Safety Messages (BSM) were parsed to extract desired data elements, and assembled into records that were stored in a SQL database
- 2. How you will use platform-independent and non-proprietary formats to ensure maximum utility of the data in the future
 - a. NREL stored the perception sensor data in their data catalog (<https://data.nrel.gov/submissions/287>)
 - a. Raw, numerical data is stored in CSV file format
 - b. Example videos are stored in AVI file format, viewable using open-source programs like VLC
 - b. ISU maintained its datasets and provided conclusion charts for inclusion in the implementation report
 - c. UA maintained its datasets and provided conclusion metrics for inclusion in the implementation report
- 3. Metadata standards you will use to describe the data
 - a. A DCAT-US file has been created for the NREL datasets for inclusion with ROSA P submission

Access Policies

In general, data from DOT-funded projects must be made publicly accessible. Exceptions to this policy are: data that contain personally identifiable information (PII) that cannot be anonymized; confidential business information; or classified information. Protecting research participants and guarding against the disclosure of identities and/or confidential business information is an essential norm in scientific research. Your DMP should address these issues and outline the efforts you will take to provide informed consent statements to participants, the steps you will take to protect privacy and confidentiality prior to archiving your data, and any additional concerns. In general, in matters of human subject research, your DMP should describe how your informed consent forms will permit sharing with the research community and whether additional steps, such as an Institutional Review Board (IRB), may be used to protect privacy and confidentiality. Additionally, when working with, or conducting research that includes Indigenous populations or Tribal communities, researcher will adhere to the CARE Principles for Indigenous Data Governance <https://www.gida-global.org/care> and make an explicit statement to that effect in this portion of the DMP.

Please provide as much information as possible:

1. Describe any sensitive data that may be collected or used;
 2. Describe how you will protect PII or other sensitive data, including IRB review, application of CARE Principles guidelines, or other ethical norms and practices;
 1. If you will not be able to deidentify the data in a manner that protects privacy and confidentiality while maintaining the utility of the dataset, you should describe the necessary restrictions on access and use;
 3. Describe any access restrictions that may apply to your data;
 4. If necessary, describe any division of responsibilities for stewarding and protecting the data among Principal Investigators or other project staff.
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1. Describe any sensitive data that may be collected or used
 - a. No sensitive data will was collected by NREL and ISU
 2. Describe how you will protect PII or other sensitive data
 - a. PII data was included in UA dataset; this dataset will not be published
 3. Describe any access restrictions that may apply to your data

- a. No restrictions were placed on NREL and ISU data within their repositories
 - b. UA is allowed to share conclusion metrics but not source data that includes PII
4. Describe any division of responsibilities for stewarding and protecting the data among Principal Investigators or other project staff
- a. NREL's data catalog is responsible for maintaining repository for their datasets

Re-use, Redistribution, and Derivatives Products Policies

Recipients are reminded:

1. Data, as a collection of facts, cannot be copyrighted under US copyright law;
2. Projects carried out under a US DOT SMART Grants is federally funded; therefore, as stated in grant language:
 1. Recipients must comply with the US DOT Public Access Plan, meaning, among other requirements, project data must be shared with the public, either by the researchers or by US DOT;
 2. That by accepting US DOT funding through this grant, recipients have granted to US DOT a comprehensive non-exclusive, paid-up, royalty-free copyright license for all project outputs (publications, datasets, software, code, etc.). This includes all rights under copyright, including, but not limited to the rights to copy, distribute, prepare derivative works, and the right to display and/or perform a work in public; and,
 3. In accordance with Chapter 18 of Title 35 of the United States Code, also known as the Bayh-Dole Act, where grant recipients elect to retain title to any invention developed under this grant, US DOT retains a statutory nonexclusive, nontransferrable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any such invention throughout the world.

Please provide as much information as possible:

1. Describe who will hold the intellectual property rights for the data created or used during the project;
 2. Describe whether you will transfer those rights to a data archive, if appropriate;
 3. Identify whether any licenses apply to the data;
 1. If you will be enforcing terms of use or a requirement for data citation through a license, indicate as much in your DMP;
 4. Describe any other legal requirements that might need to be addressed.
1. Describe who will hold the intellectual property rights for the data created or used during the project
- a. All data retained by NREL and ISU is public domain
 - b. All data retained by UA is to be withheld to prevent publishing of PII
2. Describe whether you will transfer those rights to a data archive, if appropriate; identify whether any licenses apply to the data; if you will be enforcing terms of use or a requirement for data citation through a license, indicate as much in your DMP; describe any other legal requirements that might need to be addressed
- a. N/A

Archiving and Preservation Plan

Please provide as much information as possible:

1. State where you intend to archive your data and why you have chosen that particular option;
2. Provide a link to the repository;

3. **You must describe the dataset that is being archived with a minimum amount of metadata that ensures its discoverability;**
 1. **Whatever archive option you choose, that archive should support the capture and provision of the US Federal Government DCAT-US Metadata Schema**
<https://resources.data.gov/resources/dcat-us/>
 4. **In addition, the archive you choose should support the creation and maintenance of persistent identifiers (e.g., DOIs, handles, etc.) and must provide for maintenance of those identifiers throughout the preservation lifecycle of the data;**
 5. **Your plan should address how your archiving and preservation choices meet these requirements.**
1. State where you intend to archive your data and why you have chosen that particular option
 - a. Public domain data is posted to cloud service hosted by NREL
 2. Provide a link to the repository
 - a. NREL repository: <https://data.nrel.gov/submissions/287>
 3. You must describe the dataset that is being archived with a minimum amount of metadata that ensures its discoverability; whatever archive option you choose, that archive should support the capture and provision of the US Federal Government DCAT-US Metadata Schema <https://resources.data.gov/resources/dcat-us/>
 - a. DCAT-US file has been created for the NREL datasets for inclusion with ROSA P submission
 4. In addition, the archive you choose should support the creation and maintenance of persistent identifiers (e.g., DOIs, handles, etc.) and must provide for maintenance of those identifiers
 - a. Dataset DOI: <https://doi.org/10.21949/rdvr-jf73>
 - b. Implementation Report DOI: <https://doi.org/10.21949/g3r6-5954>
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Planned Research Outputs

Dataset - "Multi-Sensor Object Detection Data from Infrastructure Sensors Deployed at Traffic Intersections in the City of Colorado Springs, Colorado, USA"

Data repository: <https://data.nrel.gov/submissions/287>

The dataset provided here was collected as a part of the US Department of Transportation (USDOT) Strengthening Mobility and Revolutionizing Transportation (SMART) project, where the City of Colorado Springs (Colorado, USA) and National Renewable Energy Laboratory (NREL) collaborated to collect object-level trajectory data from road users using multiple types of infrastructure sensors deployed at different traffic intersections. The data was collected in 2024 across multiple days at various intersections in and around the City of Colorado Springs. The goal of the data collection exercises was to learn various attributes about infrastructure sensors and to build a repository of high resolution object-level data that can be used for research and development (such as for developing multi-sensor data fusion algorithms).

Data presented here was collected from sensors either installed either on the traffic poles or hoisted on top of NREL's Infrastructure Perception and Control (IPC) mobile trailer. The state-of-the-art IPC trailer can deploy the latest generation of perception sensors at traffic intersections and capture real-time road user data. Sensors used for data collection include Econolite's EVO RADAR units, Ouster's OS1 LIDAR units and Axis Camera units. The raw data received from individual sensors is processed at the edge compute device located inside the IPC mobile Lab, and the resulting object-level data is then stored and processed offline. Each data folder contains all the data collected on the day. We have transformed (rotation then translation) the raw detections to ensure the data from all sensors is represented in the same cartesian coordinate system. The object list attributes impacted from the transformation are PositionX, PositionY, SpeedX, SpeedY and HeadingDeg. The rest of the data attribute remains untouched. Users should note that we do not claim that this transformation is perfect and there may be some misalignment among the different sensors.

Planned research output details

Title	Type	Anticipated release date	Initial access level	Intended repository(ies)	Anticipated file size	License	Metadata standard(s)	May contain sensitive data?	May contain PII?
Multi-Sensor Object Detection Data from Infrastruc...	Dataset	2025-03-04	Open	NREL Data Catalog		Custom Data Use Agreements/Terms of Use	DCAT-US	No	No