

## NTC Program Progress Performance Report (PPPR) Information Form

### For P.I.'s Use

On a semi-annual basis the NTC sponsored P.I. must report Program Progress Performance Report (PPPR) using the format specified in this PPPR Information Form. The form must be submitted electronically to the corresponding NTC Associate Director by **2/22/2016**.

**Cover Period: 9/30/2015 – 3/31/2016**

NTC Funded Project Information (Round/Year 1, 2013-2014)	
University Name	North Carolina State University
Project Title	Vehicle Trajectory Tool (VTT): Application Pilot for AMS Test bed
Principal Investigator	Nagui M. Roupail, PhD, Director, ITRE, NC State University
PI Contact Information	Email: <a href="mailto:rouphail@ncsu.edu">rouphail@ncsu.edu</a> Tel:(919)-515-1154 Fax:(919)-515-8898

The form includes the following six parts:

- Part I – Performance Indicators
- Part II – Accomplishments: What was done? What was learned?
- Part III – Products: What has the program produced?
- Part IV – Participants & Collaborating Organizations: Who has been involved?
- Part V – Impact: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?
- Part VI – Changes/Problems

*Supplementary documents/materials can be attached to this form with the submission.*

<b>Part I – Performance Indicators</b>	
<b>Reporting Period</b>	<b>9/30/2015 – 3/31/2016</b>
<b>1. Transportation-related courses offered during the reporting period that were taught by faculty and/or teaching assistants who are associated with the UTC</b>	[N/A]
Undergraduate courses	[N/A]
Graduate courses	[N/A]
<b>2. Students supported by this grant</b>	
Undergraduate students	Ian Pike under supervision of Dr. Nagui Roupail  [Student Name] [Supervisor]
Masters students	[Student Name] [Supervisor]
Doctoral students	[Student Name] [Supervisor]
<b>3. Students participating in transportation research projects funded by this grant (but not supported by this grant)</b>	
Undergraduate students	[Student Name] [Supervisor]
Graduate students	[Student Name] [Supervisor]
<b>4. Students supported by this grant who received degrees</b>	
Undergraduate degrees	[Student Name]
Masters degrees	[Student Name]

Doctoral degrees	Sangkey Kim [Student Name]
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**Part II – Accomplishments: What was done? What was learned?**

The information provided in this section allows the OST-R grants official to assess whether satisfactory progress has been made during the reporting period.

Reporting Period	9/30/2015 – 3/31/2016
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<p><b>1. What are the major goals of the program?</b></p>	<p>The National UTC aims to promote strategic transportation policies, investment, and decisions that bring lasting and equitable economic benefits to the U.S. and its citizens. The Center is concerned with the integrated operations and planning of all modes serving the nation’s passenger and freight transportation system, including the institutional issues associated with their management and investments. A balanced multi-modal approach will be used that considers freight and passenger travel mobility, reliability, and sustainability, as well as system operations during periods of both recurring and non-recurring incidents, including response to major emergencies. The modes in this theme include highway, transit, rail, and inter-modal interfaces including ports, terminals and airports. In particular, the center focuses on research, education, and technology transfer activities that can lead to (1) Freight efficiency for domestic shipping and for our international land, air, and sea ports; (2) Highway congestion mitigation with multi-modal strategies; and (3) Smart investments in intercity passenger travel facilities such as high speed rail. Major center activities are as following:</p> <ul style="list-style-type: none"> <li>• <b>Advanced &amp; Applied Research Promoting Economic Competitiveness:</b> Our research activities are multimodal/intermodal and multidisciplinary in scope, with the aims of addressing nationally and regionally significant transportation issues pertinent to economic competitiveness and providing practice-ready solutions.</li> <li>• <b>Education, Workforce Development, Technology Transfer, &amp; Diversity</b> The consortium is committed to providing high-quality transportation education and workforce development programs for a broad and diverse audience. Center’s efforts will support the development of a critical transportation knowledge base and a</li> </ul>
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	<p>transportation workforce that is prepared to design, deploy, operate, and maintain the complex transportation systems of the future.</p>
<p><b>2. What was accomplished under these goals?</b></p>	<p>Major Activities:</p> <ol style="list-style-type: none"> <li>1. Conduct and analyze off-line Database Experiments (Task 3)</li> <li>2. Develop and Test V-I-V capabilities (Task 4)</li> <li>3. Integrating the collected data with geo-fencing tools.</li> <li>4. Finalizing vehicle trajectory generation tool.</li> <li>5. Developing some real world applications (such as validation of FFS model in HCM)</li> <li>6. Storing data in a local SQL database to perform faster analysis.</li> <li>7. Developing the draft project final report (Task 6)</li> </ol> <p>Specific Objectives:</p> <p>The key objective of this research is to upgrade and pilot-test an existing vehicle trajectory collection tool (VTT) for testing the feasibility of a V-I-V system in communicating timely and spatially sensitive messages to vehicles upstream of a recurring or non-recurring bottleneck queue.</p> <p>Along with the main objective of this research, the research team has spent a considerable amount of efforts to understand the underlying data collected by i2D technology. For this purpose a series of concentrated data collection with a fleet of over 20 drivers have carried out and the high resolution trajectories are collected.</p> <p>Significant Results:</p> <ol style="list-style-type: none"> <li>1. Collection of more than 28 million second by second high resolution vehicles trajectory</li> <li>2. Develop a <i>geo-fencing tool</i> to filter collected data for further research</li> <li>3. Develop a <i>vehicle trajectory generation tool</i>.</li> <li>4. Finalizing Off-line tests through collected high resolution vehicle trajectories by controlled field experiments</li> <li>5. Finalizing VIV events and its threshold for giving information to driver on real time</li> <li>6. Further test and evaluate predesigned VIV events' list with its thresholds</li> </ol> <p>[For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results, including major findings,</p>

	<p>developments, or conclusions (both positive and negative); and 4) key outcomes or other achievements. Include a discussion of stated goals not met. As the program progresses, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.]</p> <p>[Generally, the activities and expected outputs, outcomes and impacts should not change from one reporting period to the next. However, if there are changes, please list the revisions and explain the reason(s) for the changes.]</p>
<p><b>3. How have the results been disseminated?</b></p>	<p>The research team has submitted an abstract to “International Symposium on Enhancing highway Performance” (Berlin 2016) related to the proposed an enhanced FFS model for HCM.</p> <p>[Describe how the results have been disseminated. Include any outreach activities that have been undertaken to reach members of communities who are not usually aware of these program activities, for the purpose of enhancing public understanding and increasing interest in learning and transportation careers. ]</p>
<p><b>4. What do you plan to do during the next reporting period to accomplish the goals? (10/1/2014 – 3/10/2016)</b></p>	<p>The project has been extended through March 31 2016 and the primary focus of the project team is on wrapping up the draft final report in the next reporting period.</p> <p>[Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.]</p>

**Part II – Products: What has the program produced?**

**Publications are the characteristic product of research projects funded by the UTC Program. OST-R may evaluate what the publications demonstrate about the excellence and significance of the research and the efficacy with which the results are being communicated to colleagues, potential users, and the public, not the number of publications. Many research projects (though not all) develop significant products other than publications. OST-R may assess and report both publications and other products to Congress, communities of interest, and the public.**

<b>Reporting Period</b>	<b>9/30/2015 – 3/31/2016</b>
<b>1. Journal publications:</b>	<p>[List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like. A publication in the proceedings of a one-time conference, not part of a series, should be reported under “Books or other non-periodical, one-time publications.”]</p> <p>[Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).]</p>
<b>2. Books or other non-periodical, one-time publications</b>	<p>[Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.]</p> <p>[Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).]</p>
<b>3. Other publications, conference papers and presentations</b>	<p>[Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above.]</p>

<b>4. Website(s) or other Internet site(s)</b>	[List the URL for any Internet site(s) that disseminates the results of the research and/or program activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.]
<b>5. Technologies or techniques</b>	<p>The research team has developed an in-house database running MySQL. The collected data has been stored in this database. The research team has developed and designed appropriate protocols to connect the database to GIS tools such as ArcGIS.</p> <p>The research team has generated “vehicles trajectory generation” tool that can visualize the high resolution collected data.</p> <p>[Identify technologies or techniques that have resulted from the research activities. Describe the technologies or techniques and how they are being shared. Such as Technologies or technology assessments]</p>
<b>6. Outreach activities</b>	
<b>7. Courses and workshops</b>	
<b>8. Inventions, patent applications, and/or licenses</b>	[Identify inventions, patent applications with date, and/or licenses that have resulted from the research. Submission of this information as part of an interim research performance progress report is not a

	<p>substitute for any other invention reporting required under the terms and conditions of an award; as of the date of this document, UTC Program inventions may not be submitted to the Federal government’s Interagency Edison (iEdison) invention-reporting system, but OST-R is working to make that available and will notify UTCs. For additional requirements pertaining to Patents and Copyrights, refer to General Provisions of Grants for University Transportation Centers, Section III, 14.]</p>
<p><b>9. Other products</b></p>	<ol style="list-style-type: none"> <li>1. High resolution driving behavior database (<i>with over 28 million second by second records</i>) in the MySQL database.</li> <li>2. Geo-fencing tool developed by Python scripting language which can communicate with ArcGIS tool to facilitate further directional corridor analysis with high resolution data.</li> <li>3. Vehicle Trajectory Generation tool to visualize the high resolution vehicles trajectories and specified events.</li> </ol> <p>[Identify any other significant products that were developed under this program. Describe the product and how it is being shared. Examples of other products are:</p> <ul style="list-style-type: none"> <li>• Databases</li> <li>• Physical collections</li> <li>• Audio or video products</li> <li>• Software or NetWare</li> <li>• Models</li> <li>• Educational aids or curricula</li> <li>• Instruments or equipment</li> <li>• Data &amp; Research Material</li> <li>• Other]</li> </ul>



**Part III – Participants & Collaborating Organizations: Who has been involved?**

**OST-R needs to know who has worked on the project to gauge and report performance in promoting partnerships and collaborations.**

**Reporting Period**                      **9/30/2015 – 3/31/2016**

**1. What organizations have been involved as partners?**

- Institute for Transportation Research and Education (ITRE), North Carolina State University, Raleigh, NC
- Idmec
- iTds

[Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that have been involved with the program. Partner organizations may provide financial or in-kind support, supply facilities or equipment, collaborate in the research, exchange personnel, or otherwise contribute.]

[Provide the following information for each partnership:  
 Organization Name:  
 Location of Organization: (if foreign location list country)  
 Partner’s contribution to the project (identify one or more)

- Financial support;
- In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);
- Facilities (e.g., project staff use the partner’s facilities for project activities);
- Collaborative research (e.g., partner’s staff work with project staff on the project); and
- Personnel exchanges (e.g., project staff and/or partner’s staff use each other’s facilities, work at each other’s site).]

<p><b>2. Have other collaborators or contacts been involved?</b></p>	<p>[Some significant collaborators or contacts within the lead or partner universities may not be covered by “What people have worked on the project?” Likewise, some significant collaborators or contacts outside the UTC may not be covered under “What other organizations have been involved as partners?” For example, describe any significant:</p> <ul style="list-style-type: none"> <li>• Collaborations with others within the lead or partner universities; especially</li> <li>• interdepartmental or interdisciplinary collaborations;</li> <li>• Collaborations or contact with others outside the UTC; and</li> <li>• Collaborations or contacts with others outside the United States or with an international organization.</li> <li>• Country(ies) of collaborations or contacts.]</li> </ul>

**Part IV – Impact: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?**

**DOT uses this information to assess how the research and education programs:**

- increase the body of knowledge and techniques;
- enlarge the pool of people trained to develop that knowledge and techniques or
- put it to use; and,
- improve the physical, institutional, and information resources that enable those people to get their training and perform their functions.

<b>Reporting Period</b>	<b>9/30/2015 – 3/31/2016</b>
<b>1. What is the impact on the development of the principal discipline(s) of the program?</b>	<p>[Describe how findings, results, techniques that were developed or extended, or other products from the program made an impact or are likely to make an impact on the base of knowledge, theory, and research and/or pedagogical methods in the principal disciplinary field(s) of the program. Summarize using language that an intelligent lay audience can understand (Scientific American style).]</p> <p>[How the field or discipline is defined is not as important as covering the impact the work has had on knowledge and technique. Make the best distinction possible, for example, by using a “field” or “discipline”, if appropriate, that corresponds with a single academic department (i.e., physics rather than nuclear physics). ]</p>
<b>2. What is the impact on other disciplines?</b>	[Describe how the findings, results, or techniques developed or improved, or other products from the program made an impact or are likely to make an impact on other disciplines.]
<b>3. What is the impact on the development of</b>	[Describe how the program made an impact or is likely to make an impact on transportation workforce development. For example,

<p><b>transportation workforce development?</b></p>	<p>how has the program:</p> <ul style="list-style-type: none"> <li>• Provided opportunities for research and teaching in transportation and related disciplines;</li> <li>• Improved the performance, skills, or attitudes of members of underrepresented groups that will improve their access to or retention in transportation research, teaching, or other related professions;</li> <li>• Developed and disseminated new educational materials or provided scholarships; or provided exposure to transportation, science and technology for practitioners, teachers, young people, or other members of the public?]</li> </ul>
<p><b>4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?</b></p>	<p>1- An extensive database (over 28 million records) of second by second equipped vehicle trajectories synchronized in time and space as they traverse freeway/arterial facilities over a period of 21 months. This database will be used to understand fundamental traffic flow phenomenon at a resolution and scale that is unprecedented. It will also deliver key driver behavioral data.</p> <p>2- A demonstration of V-I-V concepts and messages in near real time, and an assessment of their effectiveness</p> <p>[Describe ways, if any, in which the program made an impact, or is likely to make an impact, on physical, institutional, and information resources that form infrastructure, including:</p> <ul style="list-style-type: none"> <li>• Physical resources such as facilities, laboratories, or instruments;</li> <li>• Institutional resources (such as establishment or sustenance of societies or organizations);</li> <li>or</li> <li>• Information resources, electronic means for accessing such resources or for scientific communication, or the like.]</li> </ul>

<p><b>5. What is the impact on technology transfer?</b></p>	<p>[Describe ways in which the program made an impact, or is likely to make an impact, on commercial technology or public use, including:</p> <ul style="list-style-type: none"> <li>• Transfer of results to entities in government or industry;</li> <li>• Instances where the research has led to the initiation of a start-up company; or</li> <li>• Adoption of new practices.]</li> </ul>
<p><b>6. What is the impact on society beyond science and technology?</b></p>	<p>As part of the project tasks, this research team is investigating the Vehicle to Vehicle communication (VIV).</p> <p>[Describe how results from the program made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:</p> <ul style="list-style-type: none"> <li>• Improving public knowledge, attitudes, skills, and abilities;</li> <li>• Changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or</li> <li>• Improving social, economic, civic, or environmental conditions]</li> </ul>
<p><b>7. Additional impacts</b></p>	<p>[NTC encourages to consider identifying program results by outcomes or impacts, as suggested by the examples below. Impacts should be linked to National goals expressed in the Secretary’s Strategic Goals.]</p> <p>[Outcomes are broader changes that are expected to result from the products, such as:</p> <ul style="list-style-type: none"> <li>• Increased understanding and awareness of transportation</li> </ul>

	<p>issues;</p> <ul style="list-style-type: none"><li>• Improved body of knowledge;</li><li>• Improved processes, techniques and skills in addressing transportation issues;</li><li>• Enlarged pool of trained transportation professionals;</li><li>• Greater adoption of new technology;</li><li>• Other impacts.</li></ul> <p>Impacts are the longer-term, fundamental changes intended as a result of your activities, such as:</p> <ul style="list-style-type: none"><li>• Safer driver behavior;</li><li>• Increased travel time reliability;</li><li>• Increased intermodal transportation operations;</li><li>• Reduction in carbon and other harmful emissions from transportation sources;</li><li>• Other impacts. ]</li></ul>
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**Part V – Changes/Problems**

**If not previously reported in writing to OST-R through other mechanisms, provide the following additional information or state, “Nothing to Report, if applicable:**

<b>Reporting Period</b>	<b>9/30/2015 – 3/31/2016</b>
<b>1. Changes in approach and reasons for change</b>	<p>The research team requested NCE in the previous quarter to collect more second by second data and also to perform further investigation on understanding the data. The project team is on track to finish the project research by December 31 2015 and deliver the final report by March 31, 2016.</p> <p>[If there is nothing significant to report during this reporting period, state “Nothing to Report.”]</p> <p>[Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the OST-R grant administrator.]</p>
<b>2. Actual or anticipated problems or delays and actions or plans to resolve them</b>	<p>[If there is nothing significant to report during this reporting period, state “Nothing to Report.”]</p> <p>[Describe problems or delays encountered during the reporting period and actions or plans to resolve them.]</p>
<b>3. Changes that have a significant impact on expenditures</b>	<p>[If there is nothing significant to report during this reporting period, state “Nothing to Report.”]</p> <p>[Describe changes during the reporting period that may have a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at</p>

	less cost than anticipated.]
<p><b>4. Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards</b></p>	<p>[If there is nothing significant to report during this reporting period, state “Nothing to Report.”]</p> <p>[Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, and/or biohazards during the reporting period. If required, were these changes approved by the applicable institution committee and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.]</p>
<p><b>5. Change of primary performance site location from that originally proposed</b></p>	<p>[If there is nothing significant to report during this reporting period, state “Nothing to Report.”]</p> <p>[Identify any change to the primary performance site location identified in the proposal, as originally submitted.]</p>