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 9/16/2016.

Cover Period: 4/01/2016 – 9/30/2016

<table>
<thead>
<tr>
<th>NTC Funded Project Information (Round/Year 2, 2014-2015)</th>
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<tbody>
<tr>
<td><strong>University Name</strong></td>
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<tr>
<td><strong>Project Title</strong></td>
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<tr>
<td><strong>Principal Investigator</strong></td>
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<td><strong>PI Contact Information</strong></td>
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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.*
## Part I – Performance Indicators

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<tr>
<th>Reporting Period</th>
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### 1. Transportation-related courses offered during the reporting period that were taught by faculty and/or teaching assistants who are associated with the UTC

<table>
<thead>
<tr>
<th>Undergraduate courses</th>
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<tbody>
<tr>
<td>Graduate courses</td>
<td>CEE 776/876: Transportation Operations II (ODU) CEE 772/872: Intelligent Transportation Systems (ODU)</td>
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</table>

### 2. Students supported by this grant

| Undergraduate students | N/A |
| Masters students       | N/A |
| Doctoral students      | Gulsevi Basar |

### 3. Students participating in transportation research projects funded by this grant (but not supported by this grant)

| Undergraduate students | N/A |
| Graduate students      | N/A |

### 4. Students supported by this grant who received degrees

| Undergraduate degrees | N/A |
| Masters degrees       | N/A |
| Doctoral degrees      | N/A |
### 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.

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1. What are the major goals of the program?

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:

- **Advanced & Applied Research Promoting Economic Competitiveness:**
  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.

- **Education, Workforce Development, Technology Transfer, & Diversity**
  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 transportation workforce that is prepared to design, deploy, operate, and maintain the complex transportation systems of the future.
| 2. What was accomplished under these goals? | Our research focuses on the mitigation of highway congestion using multi-location tolling auctions in a future environment where drivers are able to use vehicle-to-infrastructure (V2I) technology to communicate with the toll operator. The focus of this reporting period’s work is two-fold: 1) development of survey instruments to support the acquisition of the data required for output analysis 2) development of mathematical models to inform agent-based simulation and analytical models.

In this period, the project team developed two survey studies to provide data for both agent-based simulation and analytical tool. Initially, both survey studies were approved by Institutional Review Board (IRB) to ensure ethical data collection from respondents.

First study was developed and conducted with the help of an online survey tool and disseminated via social media such as Twitter and Facebook, e-mails, and university announcement boards. Paper surveys were not found to be useful due to dynamic structure of the developed auction-tolling techniques. The collected data was used to develop a mathematical model to inform the agent-based simulation and to capture the drivers’ toll selection behavior. Currently, the team is working on model estimation and informing agent-based simulation with the estimated model and its analysis.

Members of the project team ran a second survey study, which used a serious game as part of in-class activities among students at Old Dominion University with the help of audiovisual materials designed and developed particularly for the study. The information collected from this game was used to inform actual Value of Time (VOT distributions) as well as information for gaining an understanding of how the tolling auction mechanics has on the participant’s response. The data collected from this study is currently being was used to inform analytical models comparing different VOT distributions. |
| 3. How have the results been disseminated? | Two papers were submitted for presentation at the TRB Annual Meeting.

The research was also presented at the Transportation Innovation & Policy Summit, University of Maryland, College Park, MD, April 14, 2016 |
| 4. What do you plan to do during the next period? | The next period of the project represents the final phase for the project. The project team plans to finish their analysis of the |
| reporting period to accomplish the goals? (10/1/2014 – 3/10/2016) | analytical model and the agent-based model. We expect to publish the results in peer-reviewed journal articles. |
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.

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<tr>
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<tr>
<td>2. Books or other non-periodical, one-time publications</td>
<td>None to report.</td>
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<p>| 4. Website(s) or another Internet site(s) | N/A |
| 5. Technologies or techniques | N/A |
| 6. Outreach activities | N/A |
| 7. Courses and workshops | N/A |
| 8. Inventions, patent applications, and/or | N/A |</p>
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<tr>
<td>9. Other products</td>
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**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.

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**1. What organizations have been involved as partners?** This project is mainly conducted at ODU as a collaborative effort between faculty from the Civil & Environmental Engineering Department and the Virginia Modeling, Analysis and Simulation Center (VMASC).

**2. Have other collaborators or contacts been involved?** Dr. Lei Zhang from the University of Maryland, in the Department of Civil and Environmental Engineering, has collaborated with the team in this phase.
**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.

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| 1. What is the impact on the development of the principal discipline(s) of the program? | Road pricing have long been recognized as a reliable method to mitigate traffic congestion and to produce funds for future transportation investments. It is expected that connected and autonomous vehicle environment is going to open new avenues for tolling. It is important to understand how public would react to these new opportunities in tolling and to collect data to generate empirical tools to understand how policies should be developed considering public and toll authorities’ goals. For this reason, in this phase, an online survey tools and in-class activities were developed and conducted for data collection and analytical model building purposes.

In the online survey, a descending price auction algorithm and second price sealed bid algorithm were introduced through different travel time savings scenarios. 148 complete responses were collected. The analysis results are two-fold. First, it was found that respondents do not oppose the new tolling methods introduced in the survey. Second, toll selection behavior was found to be different across demographics. While drivers’ age, gender, and toll familiarity were not statistically significant in toll selection behavior; drivers’ income level, education level and auction time were found to be important determinants.

In the in-class activities, the students were shown a series of videos, which were used to collect information about their value of time (VOT) estimates under different tolling scenarios. Each video showed the view from inside a moving vehicle with a projected windscreen display; the display would explain that a toll road was approaching and take the students through the bidding process systematically. 152 data points were collected but 14 were removed.
due to errors. A further 13 data points were collected for control purposes. The results show that students had vastly different VOT estimates depending on which auction tolling method was used. For example, how the students VOT estimates changed with relation to time-saving was shown to be convex in some cases and concave in others. The results also gave an empirical distribution of VOT estimates. These results are useful because they challenge the assumption that VOT estimates are independent of tolling mechanism and they provide a distribution for future researchers to use in their tolling research.

2. What is the impact on other disciplines?  

The conducted study helps fill the gap between transportation simulation and economics by incorporating different auction mechanisms into futuristic tolling environment under connected and autonomous vehicles. The collected survey data provided insights into i) the population’s value of time (VOT) estimates, ii) different toll selection behavior across demographics such as gender, age and education level and iii) public perception and attitudes towards new tolling mechanisms. In-class activities and collected data also provided insights into how tolling mechanisms affect consumer behavior.

3. What is the impact on the development of transportation workforce development?  

Courses taught at Old Dominion University give graduate students the opportunity to explore the multidisciplinary theory and techniques that will allow alternative modes of highway funding and managing vehicle-based transportation in futuristic V2I settings.

4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?  

N/A

5. What is the impact on technology transfer?  

N/A

6. What is the impact on society beyond science and technology?  

Conducting an online survey gave chance to the respondents to raise their opinions, and concerns about futuristic mechanisms via built-in comments sections, while it gave a chance to the researchers to collect and analyze the data to understand toll travel behavior and public perception. It was found out that the respondents do not outright reject the new methods, rather they are in support of new tools. In-class activities, on the other hand, provided an opportunity to understand how these new auction tolling mechanism might be received by the general public as well as
the public ability to understand them. The positive reflection from the society is expected to shape the future transportation policies in case a new tolling technology is deployed under connected and autonomous vehicle environment.

| 7. Additional impacts | The implementation of auctioning in toll plazas using V2I technologies will allow drivers to communicate their desire to use the toll road authority a price they are willing to pay. This will provide additional insights into willingness-to-pay studies. |
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:

<table>
<thead>
<tr>
<th>Reporting Period</th>
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<tbody>
<tr>
<td>1. Changes in approach and reasons for change</td>
<td>Nothing to report</td>
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<tr>
<td>2. Actual or anticipated problems or delays and actions or plans to resolve them</td>
<td>The team is asking for an extension of the project end date to December 31, 2016. Data collection effort and obtaining the IRB approvals took more time than anticipated. This extension will allow the team to complete all analyses and simulation studies.</td>
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<tr>
<td>3. Changes that have a significant impact on expenditures</td>
<td>Nothing to report</td>
</tr>
<tr>
<td>4. Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards</td>
<td>Nothing to report</td>
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<tr>
<td>5. Change of primary performance site location from that originally proposed</td>
<td>Nothing to report</td>
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