Program Progress Performance Report for University Transportation Centers
SOLARIS INSTITUTE

Safety and Operations of Large-Area Rural/Urban Intermodal Systems Institute

Submitted to:
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology (OST-R)

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Report Term: Semi-annual

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1320-117-13SU

Signature of Submitting Official:
1. Accomplishments

1.1 What are the major goals and objectives of the program?

The major goals and objectives of the program as outlined in the proposal include the following categories.

Research

SOLARIS’s research is focused on safety in addition to other U.S. DOT strategic areas. The three main research areas involve: 1) Traffic Safety Data Management and Crash Mitigation; 2) Technologies for Safe Traffic Operations and Managements; and 3) Safe and Sustainable Infrastructure. SOLARIS will conduct applied research in all of these areas to produce methodologies and tools that can be implemented to tackle long-standing and emerging transportation issues. The expected outcomes of each research topic are listed below:

Traffic Safety Data Management and Crash Mitigation

- Improved quality of safety data through better data collection and inventory
- Implementation of scientifically sound crash data analysis methodologies and software tools
- Reduction of injury and fatal crashes in both rural and urban areas
- Maximization of the rate of return for all safety project investments

Technologies for Safe Traffic Operations and Management

- Congestion mitigation to reduce travelers’ frustration and to promote safe driving
- Reduction in air pollution and noise to promote livable communities
- Efficient freight movement to improve the regional and national economy

Sustainable and Safe Transportation Infrastructure

- Improved safety, mobility, and environment for tribal lands and rural towns
- Innovative materials that will prolong the life of pavements and bridges
• Expanding and integrating advanced traffic modeling technologies into infrastructure risk analysis under earthquake and other disastrous events

*Rigorous Project Selection Process*
To aid in the project selection process, SOLARIS organized a Technical Advisory Committee composed of professionals from public and private agencies. The Technical Advisory Committee is responsible for reviewing, ranking, and recommending research projects.

**Leadership**
SOLARIS is composed of several nationally and internationally known transportation programs and academic leaders. The resources from the five institutions composing the consortium make SOLARIS a highly qualified team that can significantly contribute to the advancement of transportation research. Four ways in which SOLARIS will measure the effectiveness of its leadership include studying innovative ideas that strengthen long-term vision and goals; delivering new models and tools that are readily implementable into practice, disseminating research through journal publications and conference presentations; participating in academic and professional organizations. The leadership group includes Center Director Zong Tian, Center Coordinator Erika Hutton, and Associate Directors Pitu Mirchandani from Arizona State University and Rafiqul Tarefder from the University of New Mexico.

**Education and Workforce Development**
Education and workforce development are important to the success of SOLARIS. The universities in the consortium currently have both undergraduate and graduate programs that focus on transportation. SOLARIS plans to enhance these transportation programs by providing course material in sustainability and mobility for large sparse rural-urban regions. Another educational and workforce development goal for SOLARIS is to hold workshops, conferences, and continuing education courses in order to educate the public, industry, and academic communities. Summer camps, internships, and fellowships will also be conducted in order to attract a new generation of professionals to transportation.

**Technology Transfer**
SOLARIS has established a plan in order to provide technology transfer. This plan includes the publication of reports, peer-reviewed journals, and conference papers; showcases; seminars; webinars; and international cooperation and collaboration. UNR hosts visiting scholars to present at seminars for transportation professionals and students. PhD and Master candidates are also
presenting at seminars every week at UNR. In addition, links to principal investigators presenting research through webinars is posted on the website.

**Collaboration**

SOLARIS has outlined the framework by which collaboration within the consortium, public agencies, educational and professional organizations, and industry and other private companies will be developed. This collaboration framework aims at providing collaborative brainstorming, research, decision making, and activities related to education and technology transfer. The following list provides detailed information about the different collaborative categories.

**Collaboration within the Consortium**

Some of the collaborative efforts involving the five institutions of SOLARIS include the sharing of transportation courses via interactive classrooms and distance learning technologies. This will provide students with a broad set of transportation-related courses, which no single university would be able to offer. SOLARIS plans to create a method in which faculty members from different institutions can serve as graduate committee members. In addition, collaborative research between the institutions will best use institutional resources and expertise on delivering high quality research products.

**Collaboration with Public Agencies**

The different institutions composing SOLARIS have a strong collaborative effort with many transportation agencies. These agencies include the USDOT; the Departments of Transportation from Arizona, Nevada, and New Mexico; the Regional Transportation Commission (RTC) of Washoe County; the RTC of Southern Nevada; Maricopa County Department of Transportation, Maricopa Association of Governments, Cities of Phoenix, Tucson, and Tempe in Arizona; and the City of Las Vegas.

**Collaboration with Educational and Professional Organizations**

Outreach activities for K-12 schools and tribal colleges will focus on recruiting students that are interested in transportation research and education. The faculty members of the consortium are active in various professional organizations such as ASCE, ITE, TRB, APTA, INFORMS, and ITS America. In addition, the faculty members have or are currently serving as committee chairs in some of these organizations.
**Collaboration with Industry and Private Companies**

Partnerships with industry, industry-related organizations, and private companies are encouraged by SOLARIS in order to develop, promote and support transportation research and education. These types of collaboration efforts will effectively promote technology transfer activities.

1.2 What was accomplished under these goals?

**Research**

Quarterly progress reports are still being required to confirm projects are on schedule with a sufficient completion rate. The reports are now designed to fulfill the needs of matching organizations as well as the UTC program’s requirements.

Seven additional projects from the first round have been completed and Final Reports have been submitted or will be submitted in the next month. They have also been published on the center’s website. The total number of completed projects is now 12.

The 15 projects selected in the last round are now underway. The RFP for the third round was released in August and project selection will be completed by December.

**Leadership**

Center Coordinator Erika Hutton and Associate Directors Pitu Mirchandani (ASU) and Rafiqul Tarefder (UNM) continue their roles at SOLARIS. Dr. Nader Ghafoori continues serving as the UNLV Coordinator.

Center Director Zong Tian is a member of the planning committees for two major international conferences: International Symposium on Enhancing Highway Performance (ISEHP 2016) and 2016 World Conference on Transportation Society (WCTRS). Dr. Tian was recently promoted to Technical Area Manager (TAM) for overseeing Area C of the WCTRS, which includes four Special Interest Groups covering traffic operations, traffic safety, highway capacity and design, and intelligent transportation systems.

Dr. Tian traveled to China in July to organize and attend several major transportation conferences, including the World Conference on Transportation Research Society’s (WCTRS) Congress. This is a major international transportation conference held once every three years. It attracted more than 1500 participants from all around the world. As the chair of the Special Interest Group (SIG) C2 – Urban Transport Operations of WCTRS, Dr. Tian organized two special sessions focusing on traffic signal control. One session was held in Shanghai during WCTRS Congress, which included nine country reports, delivering the state-of-the-practice on signal control.
in these countries. Another special session was held in Tianjin with in-depth technical presentations and roundtable discussions. The session in Tianjin attracted more than 70 participants from seven different countries.

Dr. Peter Sebaaly of UNR received the College of Engineering Faculty Excellence Award for 2015-2016 in May. He is a regular PI for SOLARIS projects and is the Director of the Western Regional Superpave Center.

**Education and Workforce Development**

The Native American Scholarship has been opened year round and is posted on the SOLARIS website.

The Civil/Transportation Engineering Summer Camp at UNR took place in July. About 20 students attended the weeklong camp, participating in signal timing exercises, pavement mixtures, bridge analysis and local facility tours.

**Technology Transfer**

The center has been conducting weekly seminars. In these seminars, guest speakers and graduate students present their current research activities. Distinguished Lecturers this period included: Wuping Xin from KLD Engineering who made a presentation on April 14; John Thai from the City of Anaheim presented on May 5; Rod Schilling of NDOT presented on September 22; Brian Hoeft of FAST and Xuesong Zhou of ASU presented separate topics on September 29. Guest speakers are scheduled once a month, if possible, during the semester. The upcoming seminar schedule and past presentations are posted on the SOLARIS website.

Dr. Elie Hajj, UNR, delivered an invited presentation during the Douglas County Regional Transportation Board meeting on May 12. His presentation was on the Pavement Management System concept, implementation of a PMS for Douglas County, and different budgeting and planning scenarios.

Dr. Peter Sebaaly of UNR made a presentation on the "Effectiveness of Preventative Maintenance of Asphalt Pavements" at the Euro-Asphalt and Euro-Bitumen Conference in Prague on June 2.

Dr. Nader Ghafoori from UNLV chaired and hosted the Fourth International Conference in Sustainable Construction Materials and Technologies in Las Vegas. Over 300 technical articles from more than 40 countries presented at the conference.

Dr. Zong Tian traveled to Portland, OR to present a seminar at Kittelson and Associates, Inc. (KAI) on signal timing using the TranSync tool. The seminar was attended by KAI staff and local public agencies. Collaboration opportunities between UNR and KAI on research
and signal timing projects were discussed.

Dr. Zong Tian traveled to Tucson, AZ to provide a one-day training on TranSync. The training was attended by University of Arizona students and faculty and engineers from five local agencies who manage signal operations. TranSync is to be deployed in several arterial improvement projects in the state.

Dr. Zong Tian traveled to Southern California to conduct two workshops for Caltrans two districts: District 12 in Orange County and District 11 in San Diego. He presented an overview of the TranSync tool to Caltrans engineers and did a field demo in the field. An overwhelming response was received from Caltrans engineers and they have made a request to the headquarters to procure the tool for their district wide signal timing projects. In addition, Dr. Tian was also invited to present at the annual technology workshop at the San Diego ITE chapter. About 60 local engineers participated in the workshop.

About 10 students from CATER attended the Las Vegas Fall Transportation Conference. They delivered five presentations, and Guangchuan Yang received the best student paper award.

Dr. Rafiqul Tarefder attended the 7th International Conference on Applied Human Factors and Ergonomics where he presented “Carbon Nanotube Modified Asphalt Binders of Sustainable Roadways” in Orlando, FL.

**Collaboration**
The collaboration efforts SOLARIS has been part of during this reporting period include the following:

**Collaboration within the Consortium**
SOLARIS has successfully implemented a method in which faculty members from different institutions can serve as graduate committee members. This reporting period, Dr. Zong Tian from the University of Nevada, Reno served on a PhD Dissertation committee at the University of New Mexico. Dr. Xuesong Zhou from ASU will be serving on a PhD committee at the University of Nevada, Reno. Dr. Pitu Mirchandani from ASU has previously served on a PhD committee at the University of Nevada, Reno.

Drs. Hongchao Liu and Dali Wei from TansIntelligence, LLC visited with Dr. Tian at UNR to discuss collaboration and research opportunities. In particular, they have discussed how to further advance the features of TranSync, which has been collectively developed by TransIntelligence, LLC and UNR.
Dr. Ming Zhong from Wuhai University of Technology in China visited the CATER offices to discuss research and collaboration opportunities.

**Collaboration with Public Agencies**

The Nevada Department of Transportation Board continues to match projects to be conducted by consortium members within Nevada, including the University of Nevada, Reno, the University of Nevada, Las Vegas, and the Desert Research Institute. UNR researchers continue to work with the RTCs in both Washoe County and Las Vegas to address imminent transportation issues and improve transportation system efficiency, such as implementing new signal timing for arterial streets. Additionally, UNR researchers continue to collaborate with Caltrans in California for a project that involves design guidelines for metered on-ramps. UNR will help Carson City on a signal-timing project after the downtown roadway narrowing. UNR and University of Arizona are collaborating on pursuing research projects to improve signal coordination for City of Tucson and Arizona Department of Transportation. Dr. Tian is serving as a technical advisor on one of the on-going projects that involves evaluation of different signal control systems in the Tucson area. UNR is working with RTC, NDOT, and City of Reno on setting up a virtual traffic management center.

**Collaboration with Educational and Professional Organizations**

The center previously sponsored a graduate student interested in pursuing two advanced degrees, one in Economics and one in Transportation Engineering. Currently, graduate student Aaron Rieger is being funded by the grant and plans to pursue two advanced degrees as well. The student will work on research funded jointly by the UTC and the Regional Transportation Commission of Washoe County (RTC) on public transit accessibility by using GIS analysis and possible regressions.

UNR is collaborating with Beijing Institute of Technology, China to jointly develop a realistic signal system simulation system that would connect microsimulation, real NEMA controllers, physical small-size intersections and cars, which will be used for education and research purposes. This is the first-ever system that has been developed. It is anticipated to provide close-to-real signal control systems where students can learn the process of designing, implementing, and evaluating signal control in a lab environment. Two universities in China (Tianjin Chengjian University and Lanzhou Jiaotong University) have already made decisions on purchasing this system.
**Collaboration with Industry and Private Companies**

The Center for Advanced Transportation Education and Research (CATER) at UNR is in the process of establishing an advanced traffic signal control lab with partial sponsorship from Econolite Inc. Econolite has donated their Centracs control software for research purposes. The lab construction concluded in June 2015. The ITS lab completion is currently in process. UNR has been collaborating with Trans-Intelligence, LLC to advance the TranSync software. Trans-Intelligence provided $15,000 to support UNR’s effort.

Alon Asphalt USA, Ergon Asphalt Co. and Western Emulsions supply engineered emulsions for the conduct of laboratory experiments and provide technical input on field applications and construction techniques. The research team has also been working with local agencies such as Carson City Public Works and Douglas County Public Works to collect materials from ongoing pavement construction projects.

At a presentation visit to Kittelson and Associates by Dr. Tian, research and signal timing collaboration opportunities were also discussed. In addition, Dr. Tian has made visits to several other traffic firms in California for collaborating on research opportunities.

1.3 **What opportunities for training and professional development has the program provided?**

The weekly seminars are open to the general public, particular to local and state transportation agencies and graduate students. Webinars and training workshops are being planned to promote traffic signal timing and coordination practices.

1.4 **How have the results been disseminated?**

- Twelve total final reports have been completed and sent to the various agencies as required by the grant.
- Several presentations have been made based on the research.

1.5 **What do you plan to do during the next reporting period to accomplish the goals and objectives?**

The following tasks are planned in order to accomplish the goals and objectives of SOLARIS.

- Stay updated on funded projects and their progress.
- Update SOLARIS website and RiP as necessary.
- Attend CUTC meeting in January.
- Continue fostering professional relationships for Distinguished Lecturer seminar series.
• Conduct at least one webinar on signal timing to draw a broad range of audiences.
• Work with UC Berkeley undergraduate students on a Capstone course using the TranSync tool.

2. Products

2.1 Publications, conference papers, and presentations

Dr. Zong Tian made a presentation for the Washington, DC area ITE chapter titled "TranSync for Signal Timing Management, Optimization, Diagnosis, and Evaluation". About 30 people from local consulting firms and city/state agencies attended the luncheon meeting. The participants were given new perspectives on how signal timing and coordination can be accomplished efficiently with less effort and data requirements.

Dr. Zong Tian traveled to Portland to present a seminar at Kittelson and Associates on signal timing using the TranSync tool. The seminar was attended by KAI staff and local public agencies. Collaboration opportunities between UNR and KAI on research and signal timing projects were discussed.

Dr. Zong Tian made a presentation, titled “Critical Aspects of Signal Timing and Coordination”, at the annual ITE technology show in San Diego. About 60 transportation engineers participated in the presentation.

Dr. Elie Hajj was invited to present at the Transportation Resource Advisory Forum for Carson City on July 28. His presentation covered the PMS concept as well as implementation methods for Carson City.

Dr. Peter Sebaaly of UNR made a presentation on the "Effectiveness of Preventative Maintenance of Asphalt Pavements" at the Euro-Asphalt and Euro-Bitumen Conference in Prague on June 2.

Dr. Elie Hajj delivered an invited presentation during the Douglas County Regional Transportation Board meeting. His presentation was on the Pavement Management System concept, implementation of a PMS for Douglas County and different budgeting and planning scenarios.
Dr. Mohamed Moustafa of UNR presented “Cost and Ecological Feasibility of using UHC in Bridge Piers” at the First International Interactive Symposium on UHPC.

2.2 Website(s) or other internet site(s)
The SOLARIS website is located at http://www.unr.edu/solaris. This website is used to disseminate any information related to the program. It is updated monthly, or as needed.

2.3 Technologies or techniques
The TranSync tool will continue to be promoted to agencies to improve the current practice on signal timing and coordination.

The right-turn volume reduction guideline has been adopted by the Nevada Department of Transportation.

The pedestrian handling guide at coordinated signal systems has been used in signal timing projects in Reno and showed improved results due to minimization of signal transition.

UNR continues to develop a close-to-reality signal control system, which includes integration of TranSync, a virtual controller interface device (CID), and small-size physical intersections and cars. It is anticipated that this tool be used for class teaching and professional training purposes.

2.4 Inventions, patent applications, and/or licenses
Nothing to report for this period.

2.5 Other products
Nothing to report for this period.
3. Participants & Collaborating Organizations

3.1 Who has worked on the program?
The members of SOLARIS include the University of Nevada, Reno (UNR); the University of Nevada, Las Vegas (UNLV); Arizona State University (ASU); the University of New Mexico (UNM); and the Desert Research Institute (DRI). Table 1 lists the individuals who have worked on the program during this reporting period.

Table 1: SOLARIS Staff Working on the Program

<table>
<thead>
<tr>
<th>Name</th>
<th>Program/Project Role</th>
<th>Number of hours worked during the reporting period</th>
<th>Contribution to Program/Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zong Tian</td>
<td>Program Director</td>
<td>180</td>
<td>Oversees overall operations of the program. Responsible for coordinating with stakeholders and developing and implementing the SOLARIS Strategic Plan.</td>
</tr>
<tr>
<td>Pitu B. Mirchandani</td>
<td>Associate Director at ASU</td>
<td>100</td>
<td>Serves as liaison between SOLARIS and ASU.</td>
</tr>
<tr>
<td>Rafiqul A. Tarefder</td>
<td>Associate Director at UNM</td>
<td>80</td>
<td>Serves as liaison between SOLARIS and UNM.</td>
</tr>
<tr>
<td>Nader Ghafoori</td>
<td>UNLV Coordinator</td>
<td>40</td>
<td>Serves as liaison between SOLARIS and UNLV.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funding Support</th>
<th>UNR</th>
<th>ASU</th>
<th>UNM</th>
<th>UNLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborated with individual in foreign country</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Country(ies) of foreign collaborator</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Traveled to foreign country (for center related business)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>If traveled to foreign country(ies), duration of stay</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### 3.2 What organizations have been involved as partners?

Table 2 lists the organizations that have partnerships with SOLARIS and Table 3 lists the members of the Technical Advisory Committee.

#### Table 2: Organization Creating Partnerships with SOLARIS

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Location of Organization</th>
<th>Partners Contribution to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nevada Department of Transportation</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>Regional Transportation Commission of Washoe County</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>Regional Transportation Commission of Southern Nevada</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>Las Vegas Global Economic Alliance</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>New Mexico Department of Transportation</td>
<td>New Mexico</td>
<td>X</td>
</tr>
<tr>
<td>Maricopa Association of Governments</td>
<td>Arizona</td>
<td>X</td>
</tr>
<tr>
<td>Arizona Department of Transportation</td>
<td>Arizona</td>
<td>X</td>
</tr>
<tr>
<td>California Department of Transportation</td>
<td>California</td>
<td>X</td>
</tr>
<tr>
<td>Econolite Control Products Inc.</td>
<td>California</td>
<td>X</td>
</tr>
<tr>
<td>City of Carson City</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>Douglas County</td>
<td>Nevada</td>
<td>X</td>
</tr>
<tr>
<td>Trans-Intelligence, LLC</td>
<td>Texas</td>
<td>X</td>
</tr>
</tbody>
</table>
Table 3: Technical Advisory Committee Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Expertise</th>
<th>Position/Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nevada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tracy Larkin (Chair)</td>
<td>Operations, Design</td>
<td>Deputy Director, NDOT</td>
</tr>
<tr>
<td>Mike Fuess</td>
<td>Traffic Operations</td>
<td>Assistant District Engineering, District 2, NDOT</td>
</tr>
<tr>
<td>Ken Mammen</td>
<td>Safety</td>
<td>Chief Safety Engineer, NDOT Planning</td>
</tr>
<tr>
<td>Steve Merrill</td>
<td>Design/GIS</td>
<td>Chief Engineer, Location Division, NDOT</td>
</tr>
<tr>
<td>Troy Martin</td>
<td>Structure</td>
<td>Engineer, Bridge Division, NDOT</td>
</tr>
<tr>
<td>Nathan Morian</td>
<td>Pavement</td>
<td>Engineer, Materials Division, NDOT</td>
</tr>
<tr>
<td>Randy Travis</td>
<td>Traffic Information/Planning</td>
<td>Chief, Traffic Information, NDOT</td>
</tr>
<tr>
<td>Manju Kumar</td>
<td>Operations, Planning</td>
<td>Research Coordinator, NDOT</td>
</tr>
<tr>
<td>Jim Poston</td>
<td>ITS/Operations</td>
<td>Engineer, RTC of Washoe County</td>
</tr>
<tr>
<td>Scott Gibson</td>
<td>Pavement</td>
<td>Engineer, RTC of Washoe County</td>
</tr>
<tr>
<td>Brian Hoeft</td>
<td>Traffic Operations</td>
<td>Director of FAST, RTC Southern Nevada</td>
</tr>
<tr>
<td>Raymond Hess</td>
<td>Transportation Planning</td>
<td>Manager, Planning Division, RTC Southern Nevada</td>
</tr>
<tr>
<td>Sondra Rosenberg</td>
<td>Transportation Planning</td>
<td>Assistant Director of Planning, NDOT</td>
</tr>
<tr>
<td>New Mexico</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mohammad Moabed</td>
<td>Pavement/Traffic</td>
<td>Former District 2 Engineer, NMDOT</td>
</tr>
<tr>
<td>Parveez Anwar</td>
<td>Pavement Materials</td>
<td>Engineer, NMDOT</td>
</tr>
<tr>
<td>Arizona</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarath Joshua</td>
<td>ITS/Safety</td>
<td>Program Manager, Maricopa Association of Governments</td>
</tr>
<tr>
<td>Scott E. Nodes</td>
<td>Traffic/Design</td>
<td>Arizona DOT</td>
</tr>
<tr>
<td>Academia (External)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robert Bertini</td>
<td>ITS/Traffic</td>
<td>Professor, Portland State University</td>
</tr>
</tbody>
</table>
3.3 Have other collaborators or contacts been involved?
Caltrans is in the process of procuring the TranSync tool for their signal timing projects.

UNR is partnering with Kittelson and Associates, Inc. to propose signal control performance measures projects for Clackamas County and Oregon Department of Transportation.

4. Impact

4.1 What is the impact on the development of the principal discipline(s) of the program?
More awareness to Transportation Engineering within the college and community due to the various activities that have been created under the grant, including invited speakers, technology transfer and research.

4.2 What is the impact on other disciplines?
Currently, the grant is funding a graduate student with a degree in Economics. The student will work in collaboration with RTC to address public transit accessibility.

4.3 What is the impact on the development of transportation workforce development?
Exchange of information has been made possible through Distinguished Lecturer Seminars, which include professional and academic entities, held at the University of Nevada, Reno.

4.4 What is the impact on physical, institutional, and information resources at the university or other partner institutions?
After a new round of proposals, collaboration efforts between UNR and UNM have developed into research on autonomous vehicles.

Our research in the signal control area has attracted interests from various agencies, which could become potential sponsors.
4.5  What is the impact on technology transfer?
Several presentations have been made at international and regional conferences. The signal timing tools have been tested in various agencies to improve the efficiency of developing signal timing plans. Our proposed signal timing methodology can have a major impact on the way we do signal coordination, for example, developing timing plans without traditional manual turning movement counts.

4.6  What is the impact on society beyond science and technology?
Improved signal system efficiency not only shows significant reduction in travel time and user costs, but also the improvement on air quality due to reduction in hazardous emissions. All these will bring improved quality of life for the citizens and protection of natural resources. Each of our signal timing projects has produced emission reductions up to 25 tons annually.

5.  Changes/Problems

5.1  Changes in approach and reasons for change
Nothing to Report

5.2  Actual or anticipated problems or delays and actions or plans to resolve them
Nothing to Report

5.3  Changes that have a significant impact on expenditures
No significant impact is perceived.

5.4  Significant change in use or care of animals, human subjects, and/or biohazards
Nothing to Report

5.5  Changes of primary performance site location from that originally proposed
Nothing to Report
5.6 Additional information regarding products and impacts
Nothing to Report

6. Special Reporting Requirements
The University of Nevada, Reno’s Office of Sponsored Projects will submit Federal Financial Reports as needed.