Technology Transfer Plan for University Transportation Center at Portland State University

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National Institute for Transportation and Communities (NITC)

Technology Transfer Plan

1 Introduction

The National Institute for Transportation and Communities (NITC) is a National University Transportation Center (UTC) led by Portland State University in partnership with consortium members Oregon Institute of Technology, University of Arizona, University of Oregon, University of Texas at Arlington and University of Utah.

One of our core missions is the successful deployment of research results. This aligns with the U.S. DOT Strategic Plan's goal for innovation to *"support technology transfer and ensure the safety and security of new technologies"* and strategic objective of deployment of innovation and technology transfer to *"strengthen the technology transfer process to facilitate adoption/commercialization of market-ready transportation technologies"*.[1] Furthermore, technology deployment and implementation are prioritized in the U.S. DOT Research, Development and Technology Strategic Plan.[2]

With that in mind, the primary goals for technology transfer of NITC projects are to move research into practice and to use innovative approaches to communicate research results. More information is outlined in Section 3.1 Goals.

The NITC Technology Transfer Plan will guide our center's consideration of technology transfer potential and readiness for all research projects funded through NITC. Included in this plan is a clear process map which will ensure research results are being effectively communicated, deployed and implemented within the transportation industry and community.

2 Technology Transfer Process

Technology transfer, as defined by the U. S. DOT, includes activities conducted to facilitate the adoption of research and development outputs. Technology transfer is most effective when considered concurrently with the research and development process.[3] Accordingly, the NITC technology transfer process begins at the research proposal stage and continues beyond the lifecycle through potential adoption. The NITC Technology Transfer Plan focuses on:

- Engaging stakeholders;
- Developing project specific implementation plans;
- Identifying resources; and
- Tracking performance.

The implementation of the NITC Technology Transfer Plan will be coordinated by NITC's Education and Technology Transfer (Ed/T2) Program Manager, Lisa Patterson. Her role is to communicate with stakeholder groups, and to work with them on developing and executing project specific plans. She will be supported by

[1] U. S. DOT Strategic Plan, FY 2018-2022 https://www.transportation.gov/dot-strategic-plan
[2] U. S. DOT Research, Development and Technology Strategic Plan, FY 2017-2021 https://ntlsearch.bts.gov/inc/images/kms/StrategicPlan.pdf
[3] U. S. DOT Research, Development and Technology Strategic Plan, FY 2017-2021

NITC's Communications Director, Cait McCusker, who will be responsible for developing the appropriate products and distribution channels for the dissemination of research results.

2.1 Stakeholder Engagement

This section addresses the identification and description of the involvement of stakeholders (including funding partners) in our research program as well as how we plan to assist stakeholders in implementing and deploying research outputs.

Stakeholder engagement is critical to the success of implementation. NITC keeps the stakeholders in mind throughout the project lifecycle which enables the center to deliver research findings to the most appropriate audience. The primary stakeholder groups are:

- **Lead Researchers (PI).** The lead researcher for any given NITC project is the principal investigator (PI). PIs are affiliated with one of the consortium member universities of NITC. NITC staff coordinate closely with the PI to gain insight on their research.
- **Project partners.** NITC research is typically collaborative and encourages external partners to be involved in the research. External project partners are involved in research in a variety of ways. For example, they may provide match funding, participate in a technical advisory role, help to collect or provide data, or review some aspect of the research design.
- **Adopters.** The adopters of NITC research will depend on the type of research conducted. Target adopters range from the external project partners (e.g., engineers, planners, other professionals involved, etc.) to other researchers and the academic community. Our largest, and most important target for adoption are transportation professionals beyond the original project partners.

2.1.1 Lead Researchers (PI)

Setting expectations and guidelines at the start of the research lifecycle supports research that can strategically reach a broad range of end-users. The NITC technology transfer process identifies three milestones for the Ed/T2 Program Manager to engage PIs in information gathering in order to identify and plan technology transfer opportunities.

Proposal Stage. As part of the NITC competitive grant application, PIs must address the question of technology transfer in their project proposals. During the external evaluation process of every proposal, reviewers must consider and score the potential for technology transfer and broad impacts in their review. The likelihood of successful implementation in practice is a key criterion for project selection.

This information enables NITC staff to begin planning the dissemination and specific implementation activities that may result with the conclusion of the research. When a proposal is selected for funding, the Ed/T2 Program Manager reviews the proposed technology transfer ideas.

Progress Report. Mid-way through the life of a research project, PIs are required to submit a report to self-assess their project's progress. A key aspect of the progress reports is an evaluation of the evolving potential for impact and technology transfer. At this stage of the research, early research findings may have been conducted and provide a sense of technology readiness that could lead to implementation. The Ed/T2 Program Manager will use the information to identify, assess and categorize projects that may have potential to impact policy or change practice. The Ed/T2 Manager will work with the PI to develop a preliminary implementation plan for projects with implementation potential and iterate the implementation plan at successive progress reports (see Section 2.2 Technology Readiness Level). Other projects will be monitored for implementation and a plan may be developed at the later stages of research.

Project Conclusion / Dissemination Plan. As each research project comes to a close, the Ed/T2 Program Manager will engage PIs to obtain critical information from their project enabling NITC to disseminate their work broadly and with intention. We will attempt to synthesize and glean lessons learned, identify policy implications or specific technologies and/or methodologies that could be applied by transportation

professionals. With a clearly defined target audience, we can deliver the research into the right hands and make a lasting impact on the industry.

These three specific touchpoints (research proposal, progress report and project conclusion) are discrete times during the project lifecycle that NITC staff will use to monitor potential technology transfer and impact of a research project. Throughout the project, there are also additional times when NITC staff, specifically the communications team and Ed/T2 Program Manager, interact with PIs to broaden and deepen dissemination of research findings. See Figure 1 for NITC's project lifecycle flowchart.

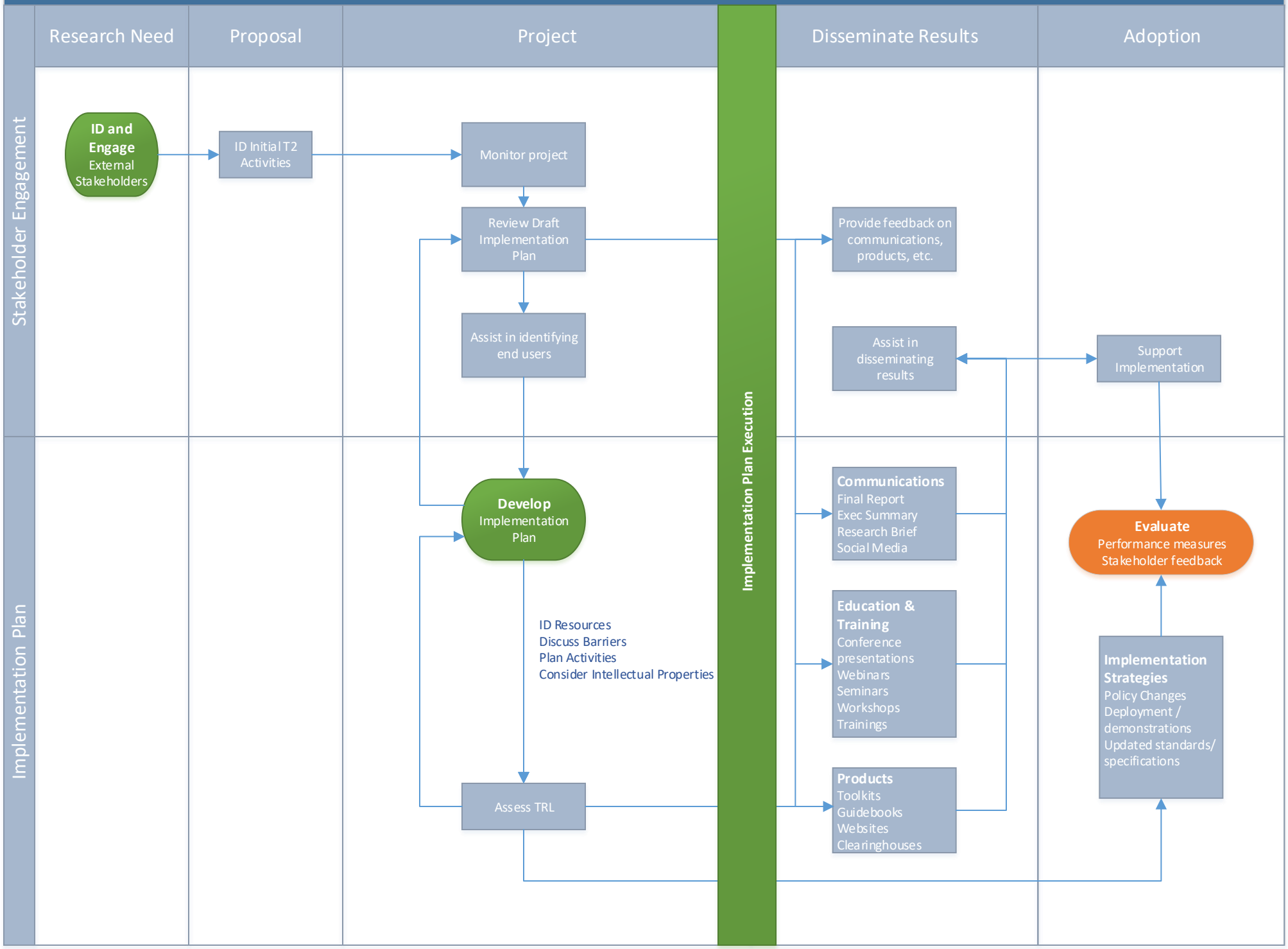
2.1.2 Project Partners

Researchers will identify and engage with external project partners when they are developing their research proposal. In the proposal, the PIs are prompted to consider forming a technical advisory committee (TAC) if one isn't already established. The Ed/T2 Program Manager can assist in this process. Identifying and engaging key stakeholders early on allows PIs to address barriers to implementation. As the research progresses, project partners can provide feedback and input to better align the research with the intended impact the project aims to achieve. Project partners are vested and can provide guidance, communicate value to other potential adopters and advocate for the technology. Project partners also have the potential to become the adopters of the research.

2.1.3 Adopters

Understanding the needs of potential adopters of the research findings or technologies is critical to the success of the technology transfer process. Identifying their anticipated role, responsibility and interest in adopting the technology will impact how and when to approach and engage with potential adopters. More information on this process is outlined in Section 2.3.1 Implementation Plan.

Figure 1: NITC Technology Transfer Process



2.2 Technology Readiness Level

Each research project is unique and will have different potential for technology transfer. While the ultimate goal is for implementation, many research projects may need further research or may never reach that potential. To assist NITC in systematically identifying technology transfer, we have developed a modified Technical Readiness Scale based on the work of the Federal Highway Administration (FHWA).

The FHWA Exploratory Advanced Research (EAR) Program created a Technical Readiness Level (TRL) scale to measure the level of readiness of a highway related technology using a series of standardized questions grouped into nine categories to assess projects at the varying levels of research maturity from basic research to implementation.[4] This scale, Technology Readiness Level for Highway Research (TRL-H), identifies the maturity of research products with an emphasis on technologies. We have modified the scale to reflect the needs and scale of our center's research findings and products.

The information gathered from PIs throughout the project lifecycle will be used as useful inputs to the NITC TRL. The NITC TRL scale will be used to assess each project at critical points in the research lifecycle in Section 2.1. In general, NITC will use the scale to determine the subsequent level of technology effort required to disseminate and / or implement research results. See Appendix for the FHWA TRL-H scale.

Table 1: NITC's TRL Scale

Scale	Level	Description	Action Required
1	Basic Research	No implementation expected - basic research, syntheses, exploratory, etc.	Dissemination of results
2	Development	Research findings are not yet ready for deployment or implementation. Project aims to further develop research.	Dissemination of results
3	Proven Concept	Research findings are proven valid in a laboratory or individual environment, but not ready for deployment at a "larger" scale.	Dissemination of results
4	Deployment	Research project targets specific practice, application or agency. Examples include demonstrations, pilot projects, proof of concept, feasibility studies.	Dissemination of results, Implementation Plan
5	Implementation	Adoption of results into practice. Examples include informing or updating policy, design guidance, specification updates, process change, commercialization.	Dissemination of results, Implementation Plan

[4] FHWA Overview of Technology Readiness Assessment Work for EAR Program
www.fhwa.dot.gov/advancedresearch/trl_h.cfm

2.3 Dissemination of Research Results

This section address the dissemination of research results.

Research results will be disseminated in a variety of ways and not all projects will be shared in the same way. Depending on where they rate on NITC's modified TRL scale, some projects will receive more "treatments" than others. At a minimum, all projects will have a final report, executive summary (maximum 2 pages), shared in the UTC's monthly research newsletter and on social media platforms.

Table 2: Research Dissemination

Communications	Education & Trainings	Products	Implementation
• Final Report • Executive Summary and Research Briefs • Monthly NITC Research Newsletter • Social Media (Facebook, Twitter, LinkedIn, Instagram, YouTube) • Targeted Press Outreach	• Conferences • Webinars (online) • Seminars (In person and streamed online) • One-day trainings • Workshops	• Toolkits • Guidebooks and handbooks • Websites • Online Data Clearinghouses	• Policy changes • Updated standards and specifications • Deployments and demonstrations • Pilot Projects

2.3.1 Implementation Plan

NITC will develop a project specific technology transfer (T2) plan for projects that reach a TRL greater than 4. These research projects have results that can specifically impact practice or direct application within practice. A project specific implementation plan will be developed by the Ed/T2 program manager with input from NITC PIs. The implementation plan will include an engagement plan and identify resources and barriers. Key elements are highlighted below.

- **Engagement.** In the implementation plan, stakeholders (specifically potential adopters) are identified along with how and when the research team will engage and what information will be collected. Questions for the stakeholders will address both their functional and process needs. For example, their interest in the research findings, their anticipated role and responsibility with the implementation of findings, their preference for type and frequency of communication.
- **Resources.** NITC has allocated a limited budget to support project-specific technology transfer activities with the highest potential for impact. The implementation plan will include a budget and identifying resources to support T2 activities. This will allow NITC to determine the level of engagement with stakeholders (e.g., PIs, project partners, adopters, etc.) and any additional resources outside of the UTC funds that will be needed to support implementation.
- **Barriers.** There are often multiple barriers to implementation of research results. Barriers to adoption are not necessarily directly related to the technology. Other non-technical or process issues may become a barrier such as policy implications, laws, funding, leadership support, resources or societal. Identifying these barriers and assessing mitigation options early on will increase the chances of adoption. If barriers are identified during the research process, PIs and NITC staff can develop and implement an action plan to address these barriers. As research findings become apparent and technology ready for adoption, the technology transfer approach can be customized.
- **Activities.** Through engagement with stakeholders, the type of technology transfer activities that will best communicate the research findings and aide the implementation process will be discussed and

identified. Activities will range and vary depending on the technology to be implemented. Examples could range from online webinars to in depth training on site at the adoption agency. Additional examples include, but are not limited to, the dissemination activities listed in Table 2.

2.4 Commercial Application

This section addresses the commercialization process of research outputs; the collection and use of licensing revenues to provide further support for research and technology transfer; and how corporate research support will be increased.

In most cases, commercial application does not apply to our projects. In some rare cases, PIs may want to license a technology or the re-use or distribution of data. If this is the case, PIs are encouraged to use the standards laid out in OMB Memorandum M-13-13, which indicates the U.S. DOT's strong preference for the use of Creative Commons licenses. PIs will have the option of setting conditions on the re-use of their materials by affixing a permission and copyright license statement, including a Creative Commons License to their work. In the case where licensing results in licensing revenue, each member campus has policies on how license revenue is distributed, including reimbursement for legal and related costs. Revenues in excess of such costs can then be used to reinvest in the activity, often helping to ensure that the product is maintained and enhanced and providing technical support for project users. Agreements are put in place prior to collection and distribution of revenues to ensure compliance with university policies, as well as relevant state and other government regulations.

For projects that have potential for commercialization, NITC will work closely with the Portland State University's (PSU) Innovation and Intellectual Property (IIP) office (as well as parallel offices at our member campuses) to address commercialization including licensing revenues, if applicable. The intellectual property from a research project resides within the home university, when the principal investigator belongs to a university other than Portland State University. Rights and responsibilities between and among partner universities for intellectual property that is jointly developed will be determined on a project-by-project basis. Such rights shall be agreed upon by the collaborating partner university and incorporated into project task orders. Each of our partner universities has an equivalent IIP office which will help coordinate commercialization that adhere to federal guidelines.

Corporate Research Support

In general, NITC research typically does not focus on technology innovation that results in corporate research investment. Regardless, NITC works closely with, and are supported by, a variety of stakeholders above and beyond match partners. This includes non-profit organizations, public agencies, other research centers, university partners, and private industry. At the beginning of the stakeholder engagement process through implementation, NITC will identify opportunities to engage corporate research to increase support. In addition, there are multiple venues where relationships with private industry is fostered. One example includes invitation to and collaboration on trainings and professional development offerings provided by NITC that highlight NITC research to a targeted audience of practitioners. Another example is NITC's Pooled Fund research program which leverages research dollars from multiple public agencies and private industry on a single, collaborative project. Each NITC campus partner has staff to ensure that partnerships with private industry comply with university policies and state and federal regulations regarding intellectual property and public access.

3 Technology Transfer Goals and Performance Measures

This section addresses technology transfer goals and performance measures and how research outputs, outcomes and impacts will be tracked and reported.

3.1 Goals

NITC has two main goals for technology transfer - to move research into practice and to use innovative approaches to communicate research results.

Move Research into Practice. Each research project will include a well-defined scope of work that identifies the problem the research will solve, how the research will address the problem and how the results will be implemented. We will continue our practice of having every final report peer reviewed by at least one academic or practitioner with relevant knowledge. We recognize that many researchers do not have the right skills and knowledge of practice to help with implementing research results. Rather, we need to bridge research and practice with the NITC Ed/T2 Program Manager who can interpret results and identify, who and how it can be best applied in practice.

Use Innovative Approaches to Communicate Research Results. Grow an ambitious program of sharing research results and tech transfer opportunities through a mix of traditional and new media. See Table 2: Research Dissemination in section 2.3 Dissemination of Research Results for more information.

3.2 Performance Measures

To achieve NITC's performance goals, we will continue to track the metrics as outlined in our UTC grant proposal and in our Program Progress Performance Report, including: number of hours and events for professional development and technology transfer; social media activity, and number of presentations at conferences. We will continue to collect these data using website analytics, surveys of people downloading our reports, reports from PIs, and reports from our Executive Committee.

Beyond these performance measures, additional outputs, outcomes and impacts of our research specific to technology transfer have been identified for tracking. For research outputs, we focus on variables that can be used to quantify the dissemination of the research findings. Outcomes are the results of our work to foster research adoption; and impacts are the societal benefits and longer-term observations.[5] Impacts will be measured by examining either indirectly or directly how research has changed the field. See Table 3 for NITC's technology transfer specific performance measures and goals.

Table 3: Performance Measure Tracking

Tracking Parameter	Performance Metric	Performance Goals & Key Performance Indicators (KPI)
Outputs	Number of final reports*	Produce final report that clearly articulate research results and meet NITC standards (KPI: 1 final report/project)
	Number of publications in trade/professional publications*	Meet or exceed the number of publications (KPI: 1 publication/project)

[5] Developing and Executing Your Technology Transfer Plan, A 10-Point Checklist. Epstein and Navarro, U.S. DOT Volpe Center, May 2018.

Tracking Parameter	Performance Metric	Performance Goals & Key Performance Indicators (KPI)
	Number of presentations at national/ international and professional/trade conferences*	Meet or exceed the number of presentations (KPI: 1 presentation/project)
	Number of events and event participants for technology transfer*	Meet or exceed number of events, professional development hours and number of attendees (KPI: 25 number of events/year with average of 50 attendees/event)
	Number of dissemination tools and products for each completed research project	Meet or exceed the number of dissemination tools or products per project (KPI: 1 brief/project)
	Number of downloads for electronic tools (databases, scripts, algorithms, etc.)	Meet or exceed the downloads per electronic tool (KPI: 20 downloads/tool)
	Number of media stories covering NITC faculty, researchers and projects*	Meet or exceed the number of media stories (KPI: 30/year)
	Percentage increase of online engagement with stakeholders (monthly NITC newsletter open and click rates; social media followers, etc.)	Meet or exceed our currently high averages for online engagement metrics (KPI: TBD)
Outcomes	Number of stakeholders who collaborated on implementing research outcomes	Meet or exceed the number of stakeholders (KPI: TBD)
	Number of projects that reach deployment and adoption.	Meet or exceed number of projects that reach TRL scale 4-5 (KPI: TBD)
Impacts	Number of stakeholders reporting impact from surveys	Meet or exceed response rate of stakeholders. (KPI: TBD)
	Number of stakeholders who have adopted, implemented or deployed research findings or technologies	Meet or exceed number of adoptions, implementations and deployments (KPI: TBD)

*Performance metrics currently included in the Program Progress Performance Report and UTC Specific Performance Indicators for NITC

These outputs, outcomes and impacts will be tracked for the entire NITC performance period. During the project period, PIs complete regular progress reports collecting some of the information. NITC staff collect the

remainder of the measures, through the website, surveys, and other data collection methods. For projects with a modified TRL scale of 4 or 5, along with an Implementation Plan (see section 2.3.1), a project close out will be conducted with the PI to discuss findings, deliverables and implementation results. In addition, during this close out process, a follow up will be scheduled with the Ed/T2 Program Manager, PIs and key stakeholders approximately six months to a year after the final report publication.

4 Appendix

TRL-H Scale[6] www.fhwa.dot.gov/advancedresearch/trl_h.cfm

	TRL	Description	To achieve the given TRL, you must answer yes to EVERY question. Discuss any uncertain answers.
Basic Research	**1**	Basic principles and research	Do basic scientific principles support the concept?
			Has the technology development methodology or approach been developed?
	2	Application formulated	Are potential system applications identified?
			Are system components and the user interface at least partly described?
			Do preliminary analyses or experiments confirm that the application might meet the user need?
	3	Proof of concept	Are system performance metrics established?
			Is system feasibility fully established?
			Do experiments or modeling and simulation validate performance predictions of system capability?
			Does the technology address a need or introduce an innovation in the field of transportation?
Applied Research	**4**	Components validated in laboratory environment	Are end user requirements documented?
			Does a plausible draft integration plan exist and is component compatibility demonstrated?
			Were individual components successfully tested in a ***laboratory environment*** (a fully controlled test environment where a limited number of critical functions are tested)?
	5	Integrated components demonstrated in a laboratory environment	Are external and internal system interfaces documented?
			Are target and minimum operational requirements developed?
			Is component integration demonstrated in a laboratory environment (*i.e.* fully controlled setting)?
Development	**6**	Prototype demonstrated in relevant environment	Is the operational environment fully known (*i.e.* user community, physical environment, and input data characteristics as appropriate)?
			Was the prototype tested in a realistic environment outside the laboratory (*i.e.**relevant environment***)?
			Does the prototype satisfy all operational requirements when confronted with realistic problems?
	7	Prototype demonstrated in operational environment	Are available components representative of production components?
			Is the fully integrated prototype demonstrated in an ***operational environment*** (*i.e.* real world conditions, including the user community)?

[6] FHWA Overview of Technology Readiness Assessment Work for EAR Program www.fhwa.dot.gov/advancedresearch/trl_h.cfm

			Are all interfaces tested individually under stressed and anomalous conditions?
	8	Technology proven in operational environment	Are all system components form, fit, and function compatible with each other and with the operational environment?
			Is the technology proven in an operational environment (*i.e.* meet target performance measures)?
			Was a rigorous test and evaluation process completed successfully?
			Does the technology meet its stated purpose and functionality as designed?
Implementation	**9**	Technology refined and adopted	Is the technology deployed in its intended operational environment?
			Is information about the technology disseminated to the user community?
			Is the technology adopted by the user community?