Task 7 Training:
Enabling Technology Readiness Assessment (ETRA)
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Office of Operations Research and Development
Program Overview
Complete Trip - ITS4US Deployment Program

- A USDOT Multimodal Deployment effort, led by ITS JPO and supported by OST, FHWA and FTA
- Supports multiple large-scale replicable deployments to address the challenges of planning and executing all segments of a complete trip

Vision

Innovative and integrated **complete trip deployments** to support seamless travel for all users across **all modes**, regardless of **location**, **income**, or **disability**
Program Goals

- Spur high-impact integrated Complete Trip deployments nationwide
- Identify needs and challenges by populations
- Develop and deploy mobility solutions that meet user needs
- Measure impact of integrated deployments
- Identify replicable solutions and disseminate lessons learned
Complete Trip Phase 1 Awardees

University of Washington
OR, WA, MD

California Association of Coordinated Transportation
CA, OR, and WA

Heart of Iowa Regional Transit Agency
Dallas County, IA

ICF
Buffalo, NY

Atlanta Regional Commission
Gwinnett County, GA
Deployment Phases

**PHASE 1: Concept Development**
- Concept Development for Complete Trip Deployment
- Establish Cohort Roundtables

**PHASE 2: Design & Test**
- Design, Test and Deploy Complete Trip Solutions
- Evaluation Framework and Planning

**PHASE 3: Operate & Evaluate**
- Demonstrate Multiple Large-Scale Deployments
- Evaluate Deployments
- Share Data & Lessons Learned

**Operations Maintenance**
- Sustain operations for a minimum period of five years after the program is completed with no supplementary federal funds

**Deployment**
- Up to 12 months
- Up to 24 months
- Minimum of 18 months

**Post-Deployment**
- 5 years
Govindarajan Vadakpat
Research Transportation Specialist
FHWA
Agenda

▪ Briefing Purpose and Outcomes

▪ Enabling Technology Readiness Assessment (ETRA) Template Walkthrough
  □ ETRA Overview
  □ ETRA Sections

▪ Resources
  □ Useful References
  □ Stay Connected
Purpose and Outcomes

- **Purpose:**
  - The aim of this presentation is to review the ETRA requirements from the BAA and the template provided by USDOT to ensure that project teams can properly address all requirements and instructions in drafting their ETRAs.

- **Outcomes:**
  - Understanding of how ETRA fits in to broader set of project deliverables
  - Clear understanding of the content for each of the sections of the ETRA Template
Enabling Technology Readiness Assessment Overview
Task 7 Deliverable

The **Enabling Technology Readiness Assessment (ETRA)** is the only Task 7 deliverable and shall systematically assess the requirements and determine the critical enabling technologies potentially utilized to develop a system that meets ITS4US user needs.

**Deliverables**

1. Draft Enabling Technology Readiness Assessment – Kick-Off + 27 weeks (August 30)
2. Final Enabling Technology Readiness Assessment * - Kick-Off + 38 weeks (November 15)

*508 Compliant Deliverable*
Task 7 Overview

- The **Enabling Technology Readiness Assessment (ETRA):**
  - Describes enabling technologies (ETs) that are part of the current system or are expected to be deployed
  - Highlights ET that will be most critical to the success of the deployment
  - Describes how current and expected ETs will be integrated into a single solution
  - Identifies if ETs are “off the shelf” or require modification or development
  - Describes the Test Readiness Level (TRL) for ETs
  - Identifies known and anticipated risks that may affect the deployment
  - Aimed at specialists with a background in technologies
# Technology Readiness Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>2021</th>
<th>2022</th>
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</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>User Needs</td>
<td>Feb</td>
<td>Project Management</td>
</tr>
<tr>
<td>Task 2</td>
<td>Concept of Operations</td>
<td>Mar</td>
<td>Apr</td>
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<tr>
<td>Task 3</td>
<td>Data Management Plan</td>
<td>May</td>
<td>Jun</td>
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<td>Task 4</td>
<td>Safety Plan</td>
<td>Jul</td>
<td>Aug</td>
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<td>Task 5</td>
<td>Performance Measurement</td>
<td>Sep</td>
<td>Oct</td>
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<tr>
<td>Task 6</td>
<td>System Requirements</td>
<td>Nov</td>
<td>Dec</td>
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<tr>
<td>Task 7</td>
<td><strong>Technology Readiness</strong></td>
<td>Jan</td>
<td>Feb</td>
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<tr>
<td>Task 8</td>
<td>Human Use Approval</td>
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<td>Task 9</td>
<td>Training Plan</td>
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<td>Task 10</td>
<td>Institutional, Partnership, and Financial Plan</td>
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<td>Task 11</td>
<td>Outreach Plan</td>
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<td>Task 12</td>
<td>SEMP</td>
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<tr>
<td>Task 13</td>
<td>Deployment Plan</td>
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<td></td>
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<tr>
<td>Task 14</td>
<td><strong>Deployment Readiness Summary</strong></td>
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## Enabling Technology Readiness Assessment Major Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Framework</strong></td>
<td>Determine and document the technology readiness framework to be used that is similar to ISO Standard 16290 Space systems.</td>
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<tr>
<td><strong>Identification of Technologies</strong></td>
<td>Identify technologies that will be utilized to meet the user needs and system requirements identified within the ConOps and SyRS.</td>
</tr>
<tr>
<td><strong>Evaluate</strong></td>
<td>Evaluate the technology based on the Subject Matter Experts (SMEs), data, test results and the resources.</td>
</tr>
<tr>
<td><strong>TRL Level</strong></td>
<td>Identify the Technology Readiness Level (TRL) of each ET based on the documented framework and evaluation process.</td>
</tr>
<tr>
<td><strong>Risk Assessment</strong></td>
<td>Perform a risk assessment for each of the enabling technologies and identify plans to mitigate high risk technology elements.</td>
</tr>
</tbody>
</table>
Enabling Technology Readiness Assessment Interdependencies

**Inputs**
- User Needs and System Requirement
  - Task 2: ConOps
  - Task 3: Data Mgmt.
  - Task 4: Safety Mgmt.
  - Task 6: SyRS

**Technology Readiness Assessment**
- Framework
- Identification of Technologies
- Evaluate
- Risk Assessment
- TRLs

**Outputs**
- TRLs and Mitigation Strategies
  - Task 12: SEMP
  - Task 13: ICTD Plan
  - Task 14: Dep. Briefing
ETRA Sections
Template Sections

1. Introduction
2. Identify Enabling Technologies
3. Technology Readiness Level
4. Risk Assessment
5. Appendices:
   Acronyms & Glossary of Terms
Section 1: Introduction

- Provides summary information about the research project and its goals, as well as how the enabling technologies help achieve USDOT’s research goals.

Subsections:
- 1.1: Intended Audience – Describes expected audience for the document.
- 1.2 Project Background – Summarizes deployment, including overall goals and intended outcomes.
- 1.3 Scope – Describes the scope of the document.
- 1.4 Goals and Objectives – Discusses how the Technology Readiness Assessment will evaluate the technologies in the deployment.
- 1.5: References and Applicable Documents - Lists any reference documents or sources with information relevant to technologies
Section 2: Identify Enabling Technologies

- Describes in detail the framework to be used and all enabling technologies (ETs) that are expected to be deployed.

- Subsection:
  
  - **2.1 Technology Readiness Framework** - Document which framework you will be basing your assignment on and why. If you are using parts of different framework provide explanation on your rational for that decision. (Options NASA, GAO, FHWA, or others)

  - **2.2: Enabling Technologies Inventory** – For each ET, provides a description, intended use, current state of the technology, vendors, system integration, and whether it is currently in use.
Enabling Technologies Inventory

- **Description:** Provide a description of the ET.

- **Integration:** Explain in detail how this ET will be integrated within the deployment system and its intended use/role. Indicate if this ET will have any adverse interactions with current systems within the deployment region, with other deployment sites selected, and/or any standards or organizations currently using the ET.

- **Procurement:** Explain if the technology is intended to be “off-the-shelf” and used as is, “off-the-shelf” and modified, or developed for this deployment. Provide information on the potential vendor(s), how it may be modified or developed, and the process used.

- **Traceability:**
  - **User Need(s):** Provide a summary describing which user need(s) are met and how they are met by this ET.
  - **System Requirement(s):** Provide a summary describing which System Requirement(s) are met and how they are met by this ET.
Enabling Technologies: Software

- Web-based Application
- Device-based Application
- mL Application
- A.I. Application
- Automation Application
- AR Application
- VR Application
Enabling Technologies: Hardware

- Automated Vehicle
- Automated Aerial Vehicle
- Connected Vehicle
- Assistive Robotics
- IoT Device
- Infrastructure Device
- Handheld/Wearable Device
Enabling Technologies: Communications

- LTE
- Wi-Fi
- 5G
- C-V2X
- Bluetooth
- DSRC
Enabling Technologies: Service Models

- Trip-Planning and Concierge Service
- Mobility Service
- Public / Government Transportation Service
- Trip Replacement
Deployment and Scalability Considerations

Integrate or augment existing ITS systems
- Utilize existing infrastructure and services when feasible
- Deploy new capabilities without adversely impacting current services

Plan for Scalability
- Consider phased roll-out to beta users
- Identify scalability risks and how to mitigate them

Performance Measure Plan
- Identify how you will collect the data to measure performance metrics
- Identify if you need to collect pre-deployment performance data
Section 3: Technology Readiness Level

- Provides the TRL for each ET listed in Section 2.

- Each individual ET and any group of integrated ETs should be included as entries in this section.

- Technical gaps and questions point to potential next steps in the technology’s development maybe uncovered.

- Subsection:
  - **Section 3.1 - TRL Assessment Process** – Describes steps taken to evaluate the technology based on the Subject Matter Experts (SMEs), data, test results and the resources.
  - **Section 3.2 – TRL Scale for each ET** – Justifies the selected TRL for each ET
TRL Progression

Collaboration

Academia ➤ Technology Development ➤ Industry

Knowledge Development ➤ Technology Development ➤ Business Development

TL1 ➤ TL2 ➤ TL3 ➤ TL4 ➤ TL5 ➤ TL6 ➤ TL7 ➤ TL8 ➤ TL9

Research to Prove Feasibility ➤ Technology development and prototypes ➤ Market launch and Commercialization
FHWA Technology Readiness Levels

- **TRL 1: Basic Principles** – Unproven Concept, no testing
- **TRL 2: Technology Concept** – Principles observed but no experimental proof
- **TRL 3: Experimental POC** – Concept and application have been formulated
- **TRL 4: Component in Laboratory** – Laboratory testing complete
- **TRL 5: Component in Environment** – Run relevant environment
- **TRL 6: System/subsystem in Environment** – System demo run in relevant environment
- **TRL 7: System Prototype in Operation** – Prototype system run in relevant environment
- **TRL 8: System in Operation** – System complete and qualified by testing and demo
- **TRL 9: System is Operation** – System has been proven in successful operations
Enabling Technology: Challenges

- **One Size fits All**
  - **Issue:** Using set TRLs that do not fit the project’s conditions.
  - **Possible Strategy:** When determining TRLs, have a process that considers the conditions of the project that will be using the technology. An ET may have a TRL of level 9 by itself but when used in the project system in new ways could potentially reduce the TE overall level.

- **Limited TRL Life**
  - **Issue:** TRL values are only valid for a limited period.
  - **Possible Strategy:** Ensure the evidence used is current and TRLs may need to be re-evaluated again later in the project.
Enabling Technology: Challenges Continued

- **Evolution Bias**
  - **Issue**: Each group have their culture, perspective, expectation or bias that can influence TRL results.
  - **Possible Strategy**: When possible, have independent sources and evaluators review the TRL results.

- **Evidence Interdependences**
  - **Issue**: TRL evidence may have dependencies, functions, and interaction with other technologies that are outside of the program.
  - **Possible Strategy**: Limit TRL evidence that have high dependencies on other technologies outside of scope and ensure your mitigation strategy address this issue.
Section 4: Risks Assessment

- Discusses all known and anticipated risks that may affect the deployment.
- Each inventoried ET should have all risks identified. Note that “risks” should be specific (e.g., performance data gaps, utilizations of standards), rather than those related to the technological maturity of a system.
- All risks are evaluated for High/Medium/Low impact on the project.
- All High Impact risks are assessed for their likelihood and plans to mitigate the risks should be described.
Useful References

- ISO Standard 16290 Space systems - Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment and by NASA [https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html](https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html)


Stay Connected

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Visit the Complete Trip - ITS4US Deployment Program Website and FAQs:
https://its.dot.gov/its4us/
https://www.its.dot.gov/its4us/its4us_faq.htm
Any questions?