Introduction

Systems Engineering is a typical part of any ITS project and is required on any federal-aid project that has an ITS work element, per 23 CFR 940.11. The MAASTO Truck Parking Information Management Systems (TPIMS) Project has followed this step by step Systems Engineering analysis to:

- Assess the system's needs and relationship to the regional ITS architectures
- Plan a project that meets stakeholder needs and expectations
- Define specific System Requirements for the project and subsystems
- Define the operations and maintenance requirements for the system
- Plan for the performance measurement and refinement of the system

The purpose of this memorandum is to detail the contents of the Systems Engineering Analysis and the Phase 1 Preliminary Design (30% design) deliverables for the MAASTO TPIMS project. Figure 1 provides a graphical representation of the steps of the Systems Engineering Process covered through 30% design as well as supplementary documents.

Figure 1: Systems Engineering “V” Diagram
The deliverables consist of state-specific and regional Systems Engineering documents as well as supplemental project documentation. Each document in the process is described in the following sections and is included on the Phase 1 deliverables flash drive.

A. Systems Engineering Documents

The final Phase 1 system engineering deliverables are categorized based on the stage of the systems engineering process in which they fall.

1. Concept of Operations

The Concept of Operations stage of the systems engineering process is a time of discovery and stakeholder engagement. These activities start defining the project on a high, region-wide level. Each state received the same documents from this stage.

Concept of Operations

The Concept of Operations document provides a high-level overview of the MAASTO TPIMS system. It covers the following topics:

- Purpose and Overview
- Scope
- Referenced Documents
- Background
- User-Oriented Project Development (stakeholder engagement)
- Operational Needs - including the project vision, needs, goals, and objectives
- System Overview
- National and Regional Project Architecture
- Core Functions Matrix
- Operation and Maintenance elements
- Operational Scenarios
- Summary of Impacts/Outcomes
- State-specific appendices which include:
  - State-specific core functions matrix
  - Statewide proposed project architecture
  - Operation, Maintenance, and Ownership responsibilities

Core Functions Matrix

Early development of the core functions matrix organized each state’s intentions for the following project attributes:

- Procurement
- Data Collection Method
- Data Collection Technology
- Operations & Maintenance
- Data Analytics & Sharing
- Information Dissemination

This document is also located in the Concept of Operations.
Stakeholder Workshop Summaries
The draft Concept of Operations was presented at two stakeholder workshops. Feedback from the stakeholder workshops were used to refine the Concept of Operations.

2. System Requirements
The System Requirements stage of this project focused on a regional level. Therefore, each state received the same documents from this stage.

System Requirements Technical Memorandum
The system requirements memo is a result of the development of the Concept of Operations document. This memo defines the user needs and requirements of the system from a regional level, but does not contain specifics of what each state is doing. It contains the following tables:
- User Needs
- System Requirements
- Traceability Matrix

Project-level ITS Architecture
The ITS Architecture for the MAASTO TPIMS project documents the attributes and associated systems, service packages, functional areas, and architecture flows. A Turbo architecture file is available along with a memorandum that describes and summarizes the project’s ITS Architecture.

ITS Architecture Consistency Review Forms
These forms capture any necessary changes or additions to the statewide and regional ITS Architectures that are affected by this project. A form has been prepared for each individual Architecture review.

3. High-Level Design (30% Design)
The High-Level Design stage of the systems engineering process is focusing more on state-specific deliverables. While each state still needs to fulfill their applicable system requirements, they can do so in their own state-specific manner. The high-level design has been completed to a 30% level as described below.

Design Requirements
The Design Requirements are more detailed, state-specific requirements that are necessary to accomplish the regional system requirements. They should reflect design standards for each state based on the type of system they are deploying. For states taking a design-build approach to procurement the design requirements are expressed as “Functional Requirements”.

Typical Site Layout
Each state’s potential truck parking sites were sorted by site type for the purposes of providing typical site layouts for the 30% design. These do not represent any particular site, but rather the general quantity and layout of each site type.
Typical Site Block Diagrams
The typical site block diagrams accompany each typical site layout and provide a high-level overview of the communications network and connections required for each respective site type.

Cost Estimates
Each site in the project was assigned a site type as described above. Each site type was analyzed to provide a high-level 30% cost estimate, taking into account factors such as the number of driveways to determine the cost. This estimate is not detailed enough to determine individual site considerations, such as foundation depth or potential tree removal.

Final Map Geodatabase
A geodatabase was created using ArcGIS to catalog TPIMS site and sign information for all eight states. This database is available for viewing online (http://arcg.is/2cFZlDL) and contains the following information:

- Site locations for all sites included in the TIGER grant, visited during the field reviews, and/or currently listed as an active project site.
- Sign locations for all signs that are part of the active project.
- Geotagged photos at each site visited in the field for power service, potential camera locations, driveways, and other general site photos.
- Data for each of the sites and signs in the database - including mile marker, direction, public or private, site type, etc.

To access this database, click on the link above or copy the link into your web-browser. The displayed map will include a box with a brief description of the data and a note that the map will be updated as the project progresses. Click “ok” on the box. You can then either use the zoom tool in the upper right hand corner of the box or use the scroll on your mouse as you would in Google Earth to each site. Site data can be accessed by clicking on each site point. There is a toolbar at the top of the screen that includes the legend, layer list, measurement tool and printer.

GIS Data
Geographic Information System (GIS) data from the field work and signs (if applicable) for each state.

State Block Diagrams
The state block diagrams provide an overview of the communications and systems connections within each state, showing the logical connections for data collection, processing, and dissemination. Each proposed MAASTO TPIMS truck parking site and sign is included. These diagrams distinguish between state and third party operations, depending on the configuration that each state has chosen.

Sign Technical Memorandum
The sign technical memorandum provides guidance for the placement of Dynamic Truck Parking Signs (DTPS) and Dynamic Message Signs (DMS) that are proposed to disseminate parking availability information. The memo also includes recommendations from the federal MUTCD committee on sign legends and best practices.
Technology Alternatives Technical Memorandum
The Technology Alternatives Technical Memorandum summarizes several of the most likely technology alternatives. The memo also includes an appendix with specific equipment information from similar projects and the MAASTO RFI responses.

Data Feed Technical Memorandum
This memorandum summarizes the standard data feed that each state will provide for their public and private truck parking sites. The data elements and formatting were agreed upon by the eight states participating in the MAASTO TPIMS project, and are intended to set a standard for future projects.

4. System Verification
The Systems Verification Plan will be developed in Phase 2 concurrently with Final Design. Verification will be performed before burn-in as a basic check that all parts of the system are built and running, and answers the question – “does the system meet the design?” States are responsible for regular testing and acceptance of their systems as they would normally proceed for an ITS project. The state-level testing will culminate with “self-evaluation” testing. Testing progress will be discussed at Phase 2 Partnership calls (held every other week) and self-evaluation documentation that supports each subsystem being tested (signs, site detection, software feed) will be collected.

5. System Validation
The Systems Validation Plan will be developed in Phase 2 concurrently with Final Design. Validation will be tied into performance measures and answers “is this system functioning up to the performance standards and addressing user needs?” The functionality of the system will be checked daily during a 60-day burn-in, and typical utilization data for each parking facility will be collected over a continuous 7-day period. Beginning with the public user go live in January 2019 performance of the system will be monitored by the Mid-America Freight Coalition (MAFC) and reported through the prescribed federal TIGER procedures.

B. Supplementary Project Documentation

Grant Related Materials
The grant related materials include a copy of the TIGER Grant Application and an excel spreadsheet that summarized the project scope (number of signs, public sites and private sites) and budget breakdown by phase (Preliminary Design, Final Design and Construction) for each state. The spreadsheet also includes a total project rollup for all states.

Environmental Documentation
The TIGER Grant Agreement requires that environmental review and approvals occur prior to Final Design. To date, all Partnership states have completed these reviews and obtained approvals through a Categorical Exclusion or Programmatic Categorical Exclusion. The documentation for the environmental review and approvals are provided on the flash drive.
Request for Information (RFI) Summary Technical Memorandum

The RFI Summary Technical Memorandum summarizes the answers received for the three RFIs and also provides the original answers in appendices.

Performance Measures Technical Memorandum

The Project Grant Agreement requires the Partnership to track and report the following Performance Measures for a period of three years immediately following the burn-in period:

- Parking Utilization and Demand Cycles
- Corridor Safety
- Reliability

The Mid America Freight Coalition (MAFC) will assist the Partnership in tracking and reporting the performance measures. The process will include the collection of baseline data prior to implementation of the system, during the burn-in period prior to deployment, and post deployment for a period of three years to assess the system over time. This technical memorandum summarizes the requirements, methodology, tracking criteria and responsibilities.

Marketing and Communications Technical Memorandum

This memorandum serves as a detailed list of stakeholder engagement and communications deliverables produced during Phase 1 of the TPIMS project. These deliverables were designed to help each state increase awareness about TPIMS as it moves past its 30% design deadline. Deliverables are listed according to the task order outlined in the project scope. A brief description of each deliverable is included, along with a link (if applicable).

ATRI Baseline Survey Technical Memorandum

As part of the project, the American Transportation Research Institute (ATRI) developed and deployed a truck parking survey in the MAASTO region. The survey results will expand existing knowledge on truck parking issues in the MAASTO region and inform the development of the TPIMS. As part of its MAASTO support work, ATRI developed a truck driver survey that contained 28 questions relating to driver demographics, truck parking issues in the MAASTO region, and TPIMS preferences. The survey was then distributed online to carriers that operate in the MAASTO region and through state trucking associations in the Midwest. In addition, the Owner Operator Independent Drivers Association (OOIDA) distributed the survey directly to drivers on behalf of ATRI. The survey was made available from July 12, 2016 to August 10, 2016. A total of 2,659 drivers responded to this survey.

TPIMS Journey Presentation

The TPIMS Journey PowerPoint has been updated to reflect the progress of the TPIMS project up to the Phase 1 milestone. The PowerPoint features information on how the project originated, how the system will work and where the project is moving forward. The PowerPoint can be used by any team member that is presenting at a conference or any other applicable setting.
Partnership Taskforce Workshop Summaries

The Partnership Taskforce, comprised of representatives from all the project states, met in-person throughout the preliminary design process at four workshops:

- Workshop #1: Kickoff, Goal Setting, Risk Assessment, Concept Refinement
- Workshop #2: Presentation of the Draft Concept of Operations and System Requirements
- Workshop #3: Presentation of the Draft Conceptual Design
- Workshop #4: Phase 2 Preparation for Final Design, Review TIGER Grant Reporting Requirements and Schedule

A full summary of these workshops and the PowerPoint are provided on the flash drive.

ProjectWise Guest Access Form

HNTB has set up a ProjectWise site as a repository for all project documents. Staff from each of the states who require access to these documents will need to fill out this form and send back to bcomer@hntb.com.