



U.S. Department of Transportation

COMPLETE TRIP

ITS  US

The logo for ITS4US, where the number '4' is stylized with a blue outline and a yellow dashed line path. The path starts at a red location pin at the top, goes down to a yellow dot, then left to another yellow dot, then down to a third yellow dot, and finally down to a red location pin at the bottom. The letters 'ITS' and 'US' are in a bold, dark grey sans-serif font.

Task 6 Training:
System Requirements Specification (SyRS)



Deborah Curtis

Highway Research Engineer

Office of Operations Research and
Development

Agenda

- **System Requirements Specificaion (Task 6) Overview**

- **System Requirements Specificaion Template**
 - Project Overview
 - General System Description
 - System Capabilities, Conditions, and Constraints
 - System Interfaces

- **Final Thoughts**
 - Useful References
 - Stay Connected

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

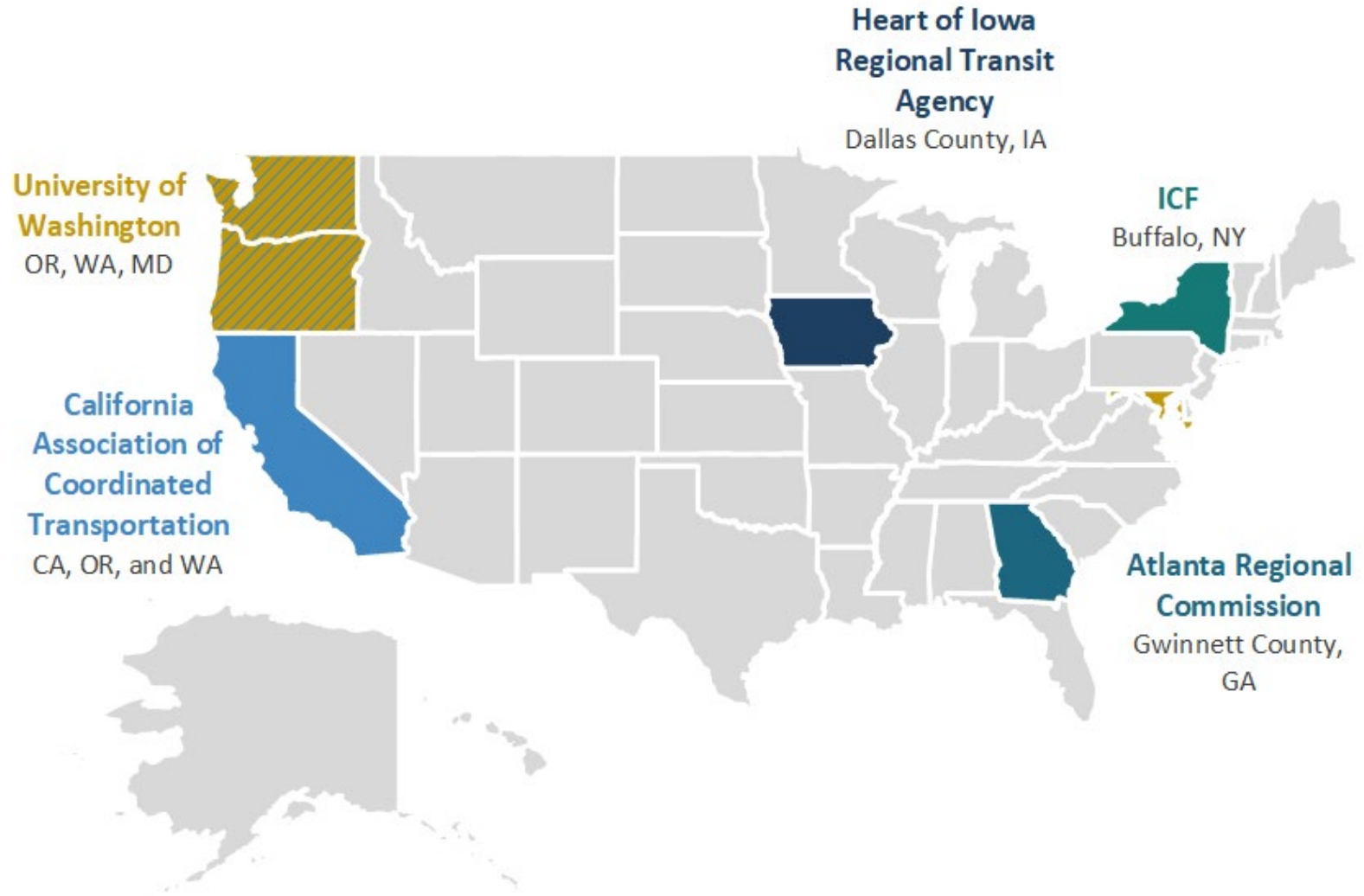


Measure impact of integrated deployments

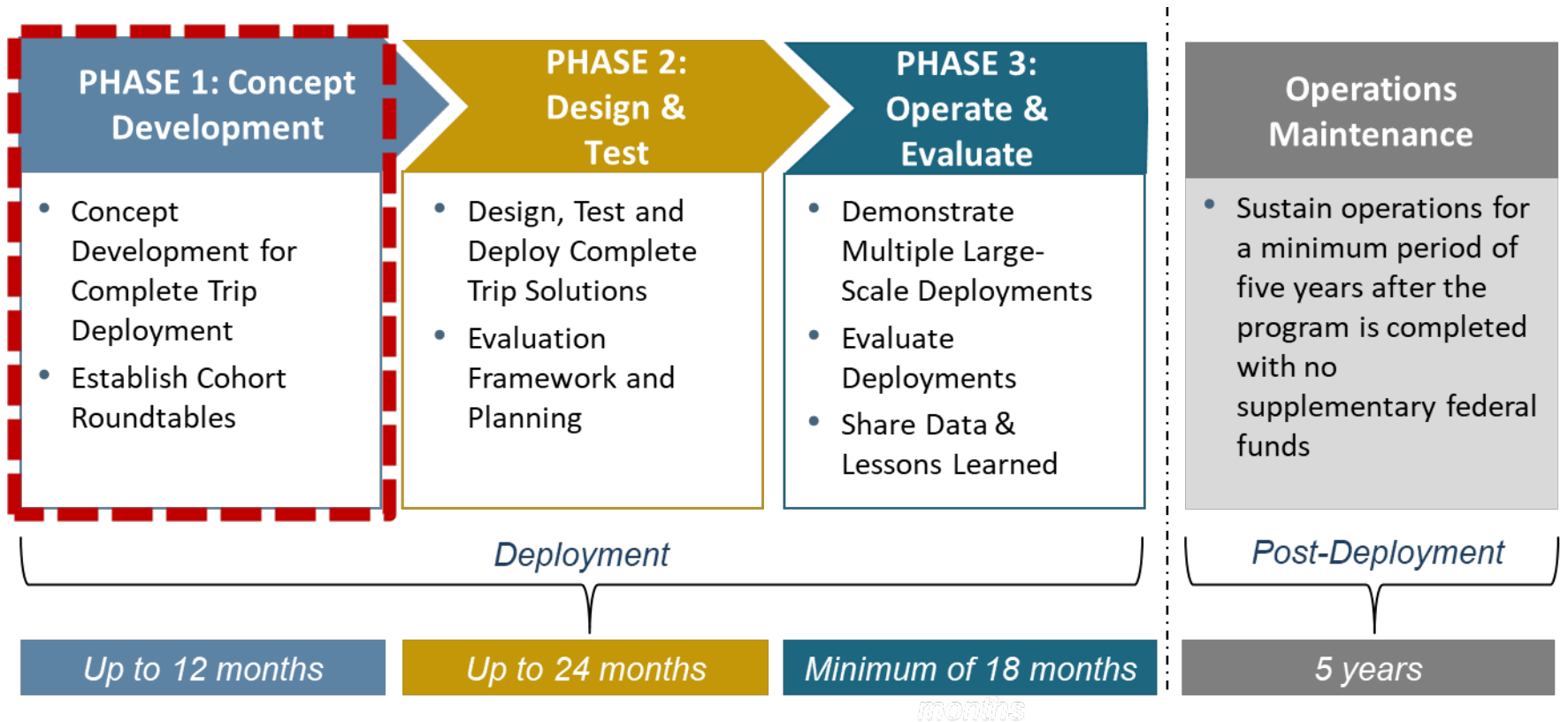


Identify replicable solutions and disseminate lessons learned

Complete Trip Phase 1 Awardees



Deployment Phases



System Requirements Specification (SyRS)

Task 6 Overview

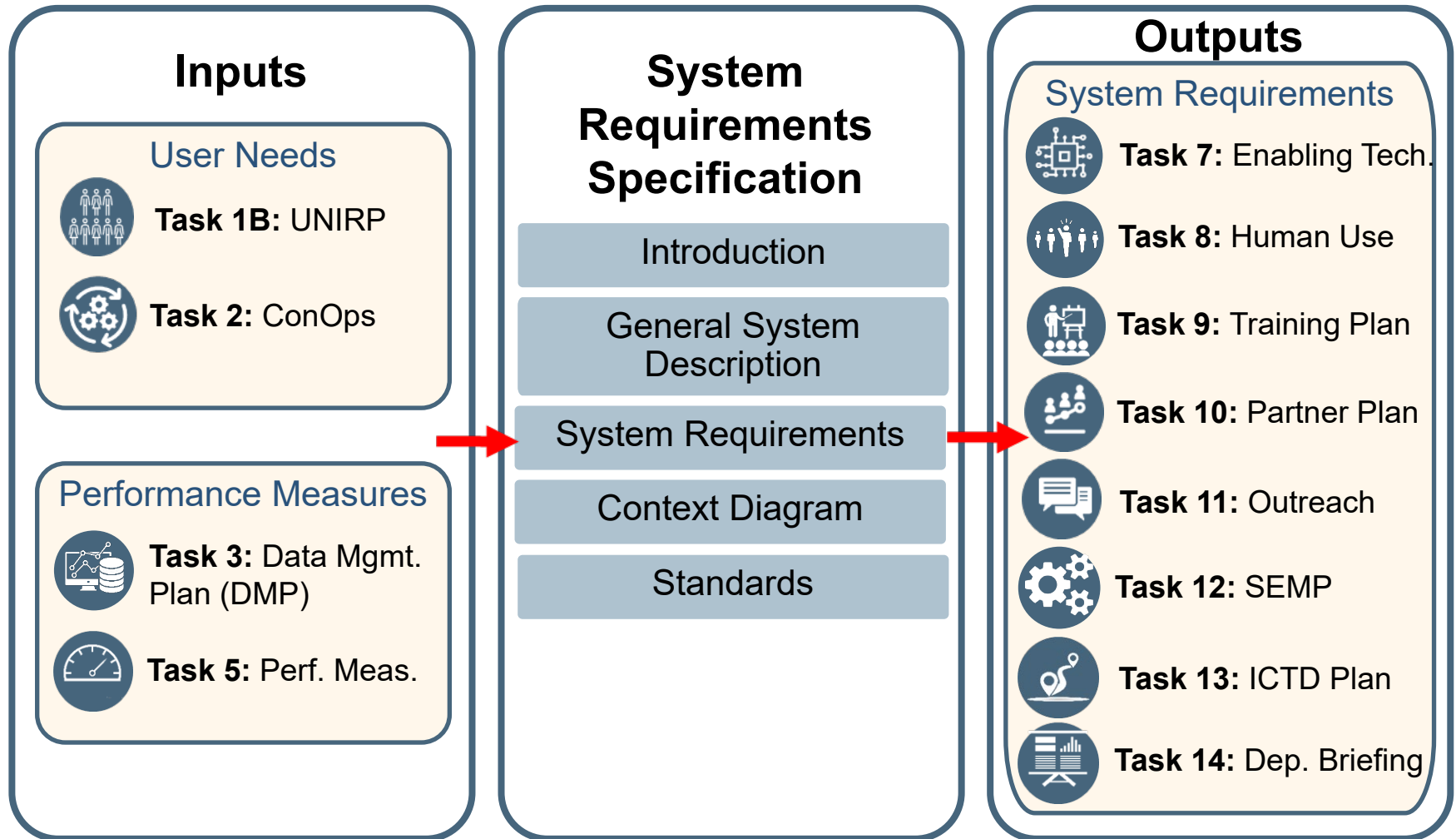
- **A Systems Requirement Specification:**
 - Identifies, organizes, and presented requirements that satisfy the needs of the system;
 - Defines the functional, performance, data and interface requirements for the subsystems and system.

- Major components of the Specification:
 - General System Description
 - System Requirements and Interfaces
 - Needs to Requirements Matrix

Deliverables

ID	BAA Section	Task 3: Data Management Plan (DMP)	Due Date	Format	Site Specific Date
P1T06D1	6.1	Stakeholder SyRS Review Panel Roster Draft	8/16/2021	Word	
P1T06D2	6.2	Stakeholder SyRS Review Panel Roster Final	8/30/2021	Word	
P1T06D3	6.3	System Requirements Specification Document Draft	9/20/2021	Word	
P1T06D6	6.6	System Requirements Specification Document Final	10/25/2021	Word	
P1T06D4	6.4	Walkthrough Workbook	9/20/2021	Word	
P1T06D5	6.5	Walkthrough Comment Resolution Report Draft	10/4/2021	Word	
P1T06D7	6.7	Walkthrough Comment Resolution Report Final	10/25/2021	Word	

SyRS Interdependencies



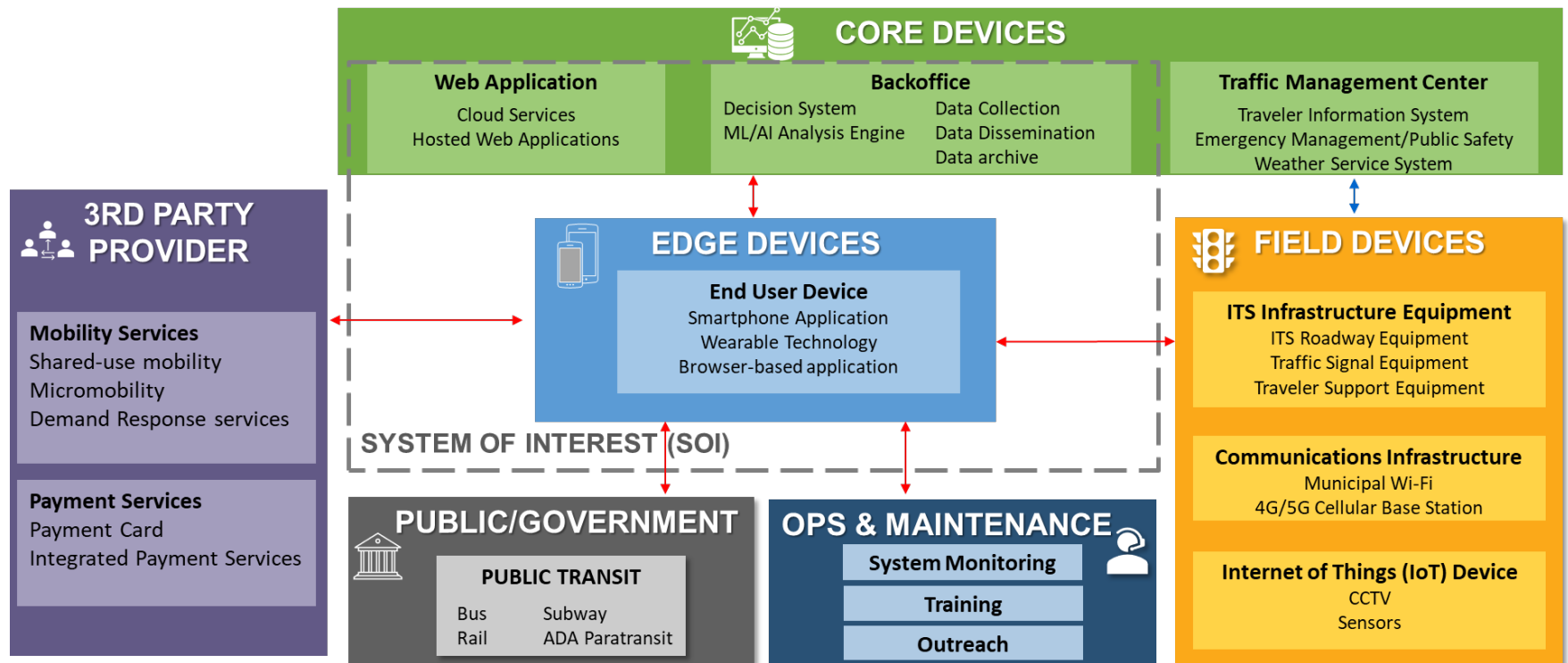
SyRS Template Sections

Section 1: Introduction

- Sections 1.1, 1.2 and 1.5 of the SyRS should address:
 - **1.1 System Purpose:** Discuss the relationship between the user needs defined in the ConOps and requirements to be defined in this document.
 - **1.2 System Scope:** Identify the proposed system(s), establish how the system(s) will meet the needs identified in the ConOps, and define and quantify the expectations of the system(s).
 - **1.5 System Overview:** Describe the functionality of the system(s) at a high-level.

Section 2: General System Description

- Section 2.1 System Context uses a system context diagram to:
 - Provide an overview of the system
 - Define where internal and external interfaces of the system exist.

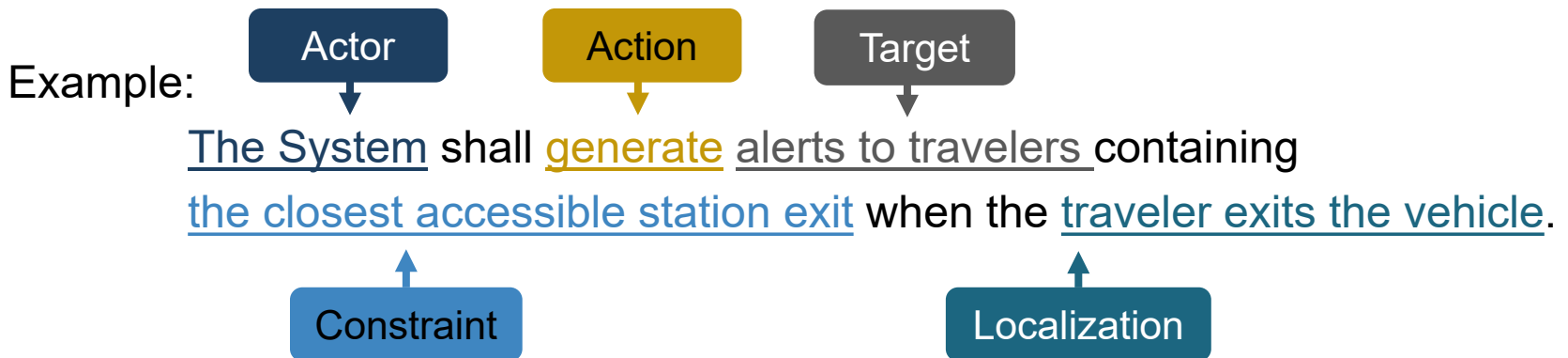


Sections 2.2 to 2.6

SyRS Section	ConOps Section	Action for SyRS
2.2 System Modes and States	5.5 Modes of Operations for Proposed System	Expand, include diagram if needed
2.3 Major System Capabilities	5.2 Description of the Proposed System	Describe the major capabilities of the system and set the logical structure for requirements organization
2.4 Major System Conditions, Constraints, Assumptions and Dependencies	4.5 Assumptions and Constraints 5.6 Operational Polices and Constraints	Describe conditions: other systems, infrastructure, environment, polices
2.5 User Characteristics	5.3 Stakeholders and Actors of the Proposed System	Describe how users interact with and use the system
2.6 Operational Scenarios	6 Operational Scenarios	Summarize existing and add additional scenarios that have been developed since ConOps

Section 3: System Capabilities, Conditions, and Constraints

- Requirements have a simple grammar:
 - Actor [The System]
 - Action [shall do/not do something to]
 - Target [the object of the action]
 - Constraint [how, how often, how many, how fast]
 - Localization [if, when, where]
 - Note: Not all requirements will have both localization and constraint portions.



Best Practices for System Requirements

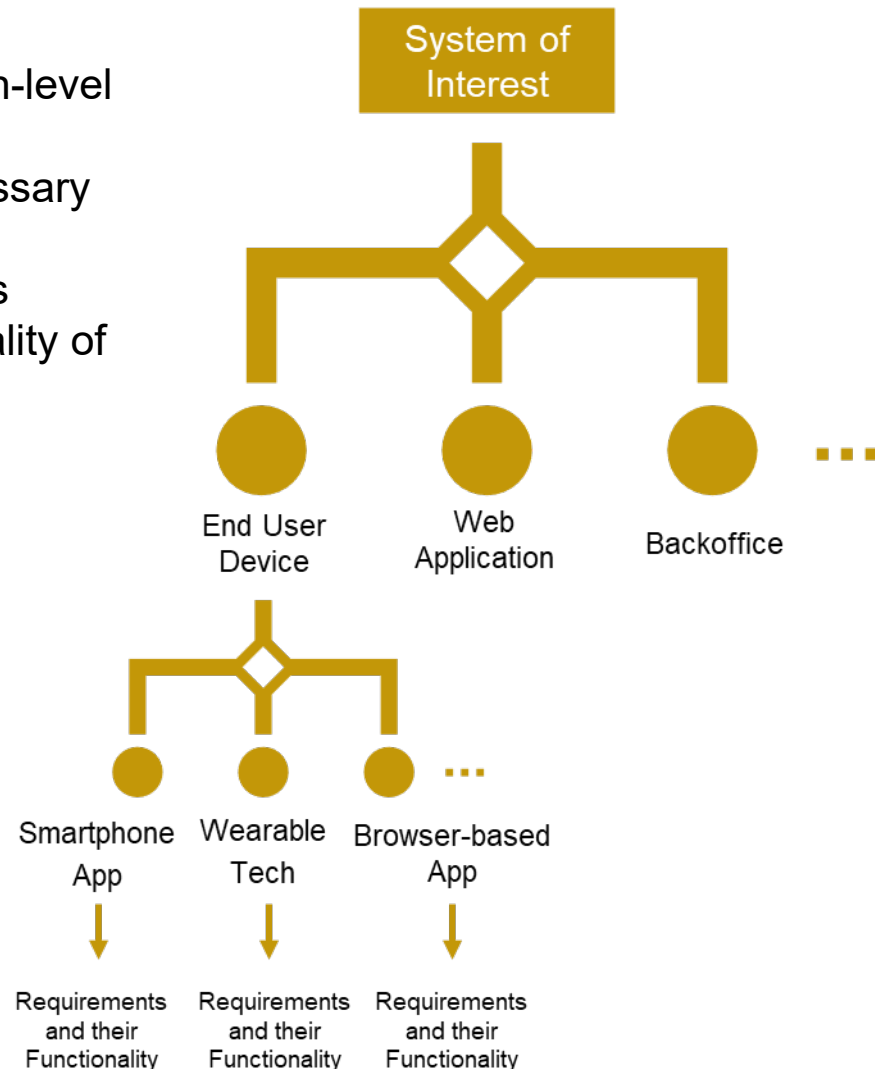
- Criteria for well-formed system requirements that fulfill a need:
 - Necessary
 - Concise
 - Implementation-free
 - Attainable
 - Complete
 - Consistent
 - Traceable
 - Unambiguous
 - Verifiable
 - Allocate-able
 - Style-compliant

Ambiguous language to avoid:

Efficient, Effective, Best, Approximate, Good, Should, Similar,
State of the Art, User Friendly

Section 3.1: Functional System

- This section should describe high-level system requirements. In a more complex system, it may be necessary to break these down into the subsystems. These requirements should contain the core functionality of the system and needs.



Section 3.2: Physical

- Describe the physical requirements of the system, this will most likely be hardware and/or infrastructure requirements of the system. Break the physical requirements into the following four categories:

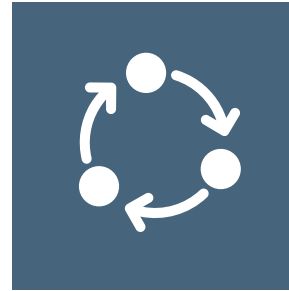
Construction



Durability



Adaptability



Environmental Conditions



Section 3.3: System Performance Characteristics

- Define the performance requirements of the system, including quantitative performance characteristics that the system shall meet in order to fulfill the user needs. These may include:

Time-based Functions:

Amount of Time



Dynamic Actions:

Rate



Speed



Noise Level



Light Level



Section 3.4: System Security and Privacy

- Specify requirements for the cyber and physical security of the system, with protecting personally identifiable information (PII) as a top priority. These requirements must address:

Cyber Security:

Security

Privacy

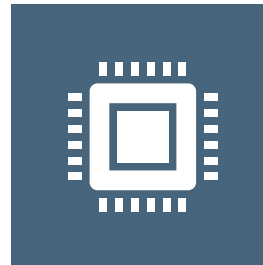


Physical Security:

Hardware

Infrastructure

Users



Section 3.5: Information Management

- Detail requirements within the system to manage user privacy and data such as:

Passwords



Encryption



Access Levels



Section 3.6: System Operations

- **System Human Factors:** Requirements pertaining to all interactions between the user and the system
 - This section will be particularly important for the ITS4US Program as each deployment will need to meet the needs identified in Task 2 for users of with disabilities, travelers of low-income, older adults, and other underserved populations.
- **System Maintainability:** Quantitative requirements regarding maintenance activities and support of the system.
- **System Reliability:** Quantitative reliability requirements and the conditions under which the requirements are to be met.

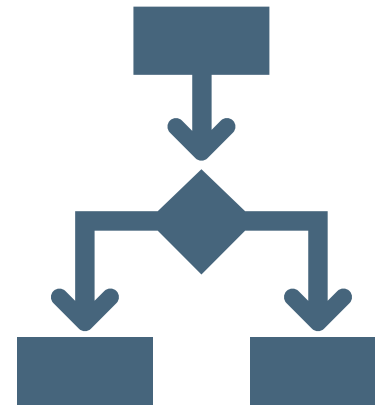
Section 3.7: Policy and Regulation

- Build upon the policies described in section 5.6 of the ConOps and detail the requirements of the system to meet the policies that may impact the operation or use of the system. This should include:
 - Organizational policies
 - External regulatory requirements
 - External regulatory constraints



Section 3.8: System Life Cycle Sustainment

- Describe the system lifecycle sustainment which includes:
 - Quality Activities:
 - Review
 - Measurement collection and analysis
 - Evolution of System:
 - New technology
 - New user needs
 - New ideas
 - Enhancements



Section 4: System Interfaces

Internal System

- Internal system components will need to communicate, this may include:
 - Interfaces between hardware
 - System and operators
 - System and users

External System

- External interfaces between the system and other system shall also be covered. This may include:
 - Interdependencies
 - Communication protocols
 - Standards to be used
 - Formats
 - Geographical representation

Appendix A. Needs to Requirements Traceability Matrix

- The Needs-To-Requirements Matrix (NRTM) is a critical tool for ensuring that your system requirements cover all of the user needs.
- It is important that the NTRM traceability is maintained through the entire process as it is the first link from the user needs into the details of the system. Without this traceability it becomes impossible to determine if the system fulfills the user needs when complete.

Example NRTM

<i>User Need / Requirement ID</i>	<i>Need/Requirement Text</i>
2.6.2.1	Transferring from subway platform to other transportation modes. <i>Transit users need to navigate from the subway platform to other modes of transportation. A solution that helps the user navigate from the location where they disembark the subway train to the location where they can access a shared use service, will allow the user to change modes and continue their trip.</i>
ER-1	<i>The system shall operate within an indoor or outdoor subway station.</i>
ER-2	<i>The system shall operate within a loud environment (>80 db) such as a crowded transit station.</i>
FR-3	<i>The system shall...</i>
2.6.2.1.1	Accurate positioning inside buildings. <i>Transit users with disabilities need to be able to accurately locate their position within buildings. In order to navigate through a transit station, the user needs accurate positioning data.</i>
DR-5	<i>The system shall provide point-of-interest (POI) locations to the user to aid in localization.</i>
DR-6	<i>The system shall collect GPS location data, if available, from the user's device.</i>
FR-8	<i>The system shall provide GPS corrections via Wi-Fi location when available.</i>
PR-10	<i>The system shall locate users within 1-meter accuracy inside a transit station.</i>

Key

FR: Functional Requirement

DR: Data Requirement

PR: Performance Requirement

Final Thoughts

Useful References

FHWA

- FHWA's Systems Engineering for Intelligent Transportation Systems <http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf>
- FHWA Systems Engineering Guidebook for ITS, Concept of Operations Template http://www.fhwa.dot.gov/cadiv/segb/views/document/sections/section8/8_4_5.cfm
- FHWA Applying Scrum Methods to ITS Projects <https://rosap.ntl.bts.gov/view/dot/32681>

State DOT

- North Dakota Department of Transportation Overview of Systems Engineering Process. <http://www.dot.nd.gov/divisions/maintenance/docs/OverviewOfSEA.pdf>

IEEE

- IEEE Guide for Developing System Requirements Specifications, IEEE Standard 1233, 1998, 10.1109/IEEESTD.1998.88826
- IEEE Guide for Software Reviews and Audits, IEEE Standard 1028-2008, 10.1109/IEEESTD.2008.4601584
- ISO/IEC/IEEE International Standard - Systems and Software Engineering -- Life Cycle Processes -- Requirements Engineering, IEEE/ISO/IEC 29148-2018, <https://standards.ieee.org/standard/29148-2018.html>

NASA

- NASA Systems Engineering Handbook <https://www.nasa.gov/seh/appendix-c-how-to-write-a-good-requirement>

Stay Connected

For more information please contact:

Elina Zlotchenko, ITS JPO
ITS4US Program Manager
Elina.Zlotchenko@dot.gov

Deb Curtis, FHWA HRDO
ITS4US Systems Engineering Lead
deborah.curtis@dot.gov

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?

