



U.S. Department of Transportation

## COMPLETE TRIP

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ITS4US

The logo for ITS4US, where the number '4' is stylized as a blue '4' with a dashed orange line path and red location pins at the start and end points, suggesting a route or journey.

**Task 2 Training:**  
Concept of Operations



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FHWA-Office of Operations, Research, and  
Developmentt

# Agenda

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- **Brief Program Overview**
  
- **Concept of Operations (ConOps) Development**
  - Deliverable Overview
  - ConOps Overview
  - ConOps Sections
  - ConOps Walkthrough
  
- **Resources**
  - Useful References
  - Stay Connected

# Program Overview

# Complete Trip - ITS4US Deployment Program

- A USDOT Multimodal Deployment Effort, led by ITSJPO 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

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Spur high-impact integrated Complete Trip deployments nationwide



Identify needs and challenges by populations



Develop and deploy mobility solutions that meet user needs

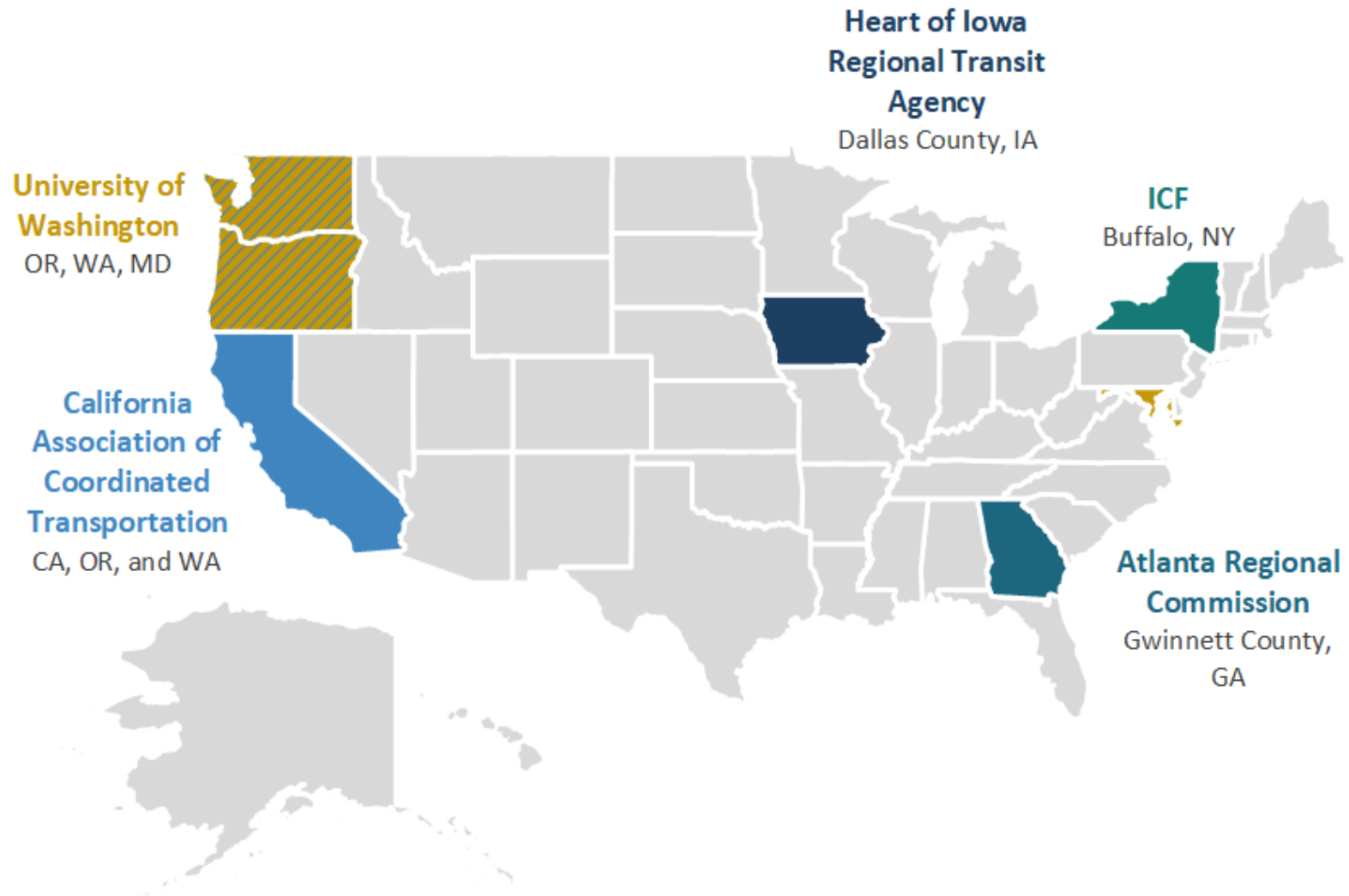


Measure impact of integrated deployments

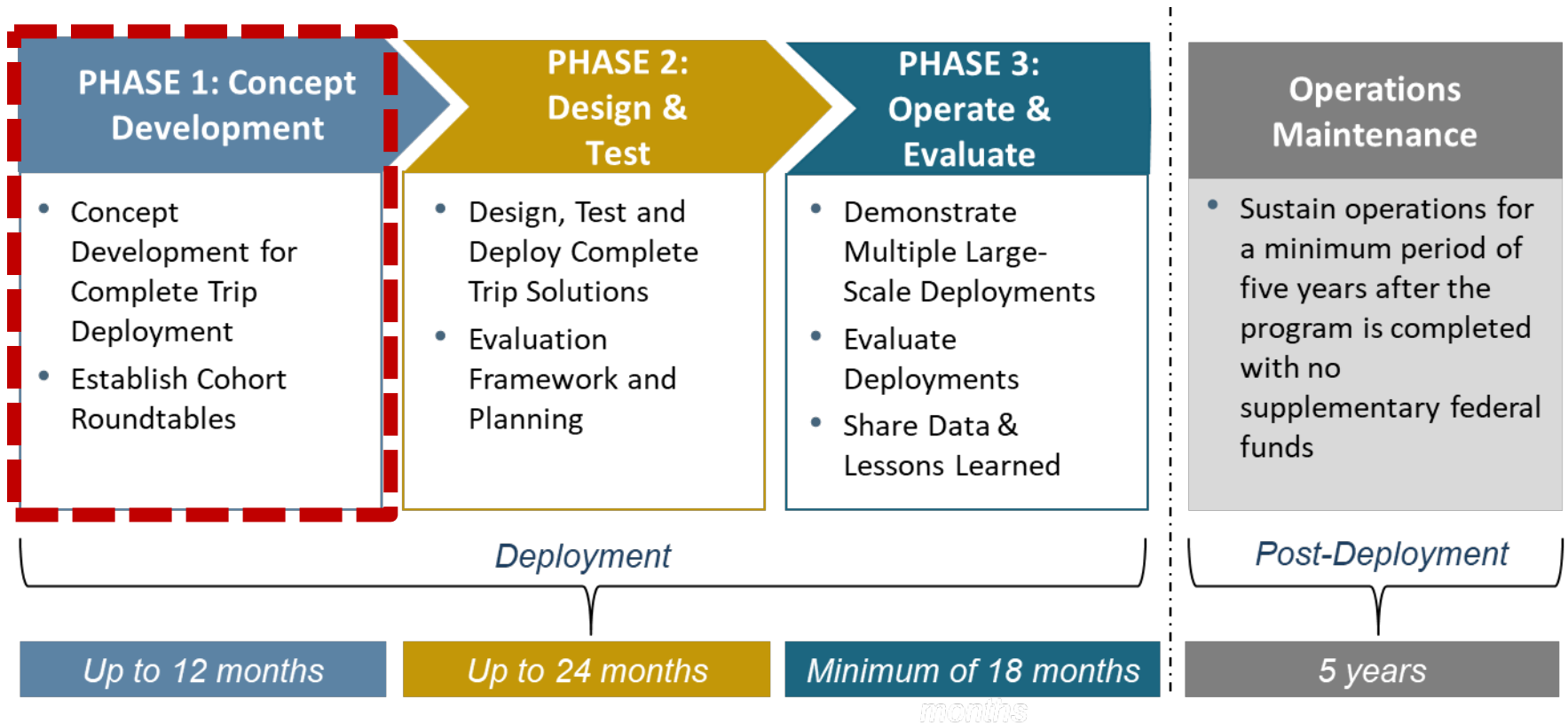


Identify replicable solutions and disseminate lessons learned

# Complete Trip Phase 1 Awardees



# Deployment Phases





# Task 2: Concept of Operations (ConOps)



# ConOps Overview

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- The ConOps baselines the concept for deployment for all stakeholders and guides the rest of the project by:
  - Refining a set of priority needs for a new system/deployment through structured stakeholder interactions
  - Defining a set of key performance measures
  - Defining the existing environment and system
  - Documenting high-level enabling technologies to be deployed
  - Describing Improvements and outcomes expected from the deployment

# Concept of Operations (ConOps)

The purpose of the task is to refine the proposed deployment concept and document in a Concept of Operations that describes the specific combination of applications to be deployed, and how operational practice will be altered based on the introduction of these applications.

## ***Deliverables***

1. Draft Stakeholder ConOps Review Panel Roster – Kick-Off + 8 weeks (April 19<sup>th</sup>)
2. Draft Needs Summary – Kick-Off + 8 weeks (April 19<sup>th</sup>)
3. Final Stakeholder ConOps Review Panel Roster – Kick-Off + 10 weeks (May 3<sup>rd</sup>)
4. Final Needs Summary – Kick-Off + 10 weeks (May 3<sup>rd</sup>)
5. Draft ConOps – Kick-Off + 13 weeks (May 24<sup>th</sup>)
6. ConOps Walkthrough Briefing Deck – Kick-Off + 13 weeks (May 24<sup>th</sup>)
7. Draft ConOps Comment Resolution Report – Kick-Off + 15 weeks (June 7<sup>th</sup>)
8. Final ConOps – Kick-Off + 18 weeks (June 28<sup>th</sup>)
9. Final ConOps Comment Resolution Report – Kick-Off + 18 weeks (June 28<sup>th</sup>)
10. Public ConOps Webinar – Kick-Off + 21 weeks (Week of July 19<sup>th</sup>)

# ConOps Major Components

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## Scope

Provide an overview of the ConOps document and the system to which it applies.

## Reference Documents

List the document number, title, revision, and date of all documents referenced in the ConOps document.

## Current System and Environment

Describe the system or situation as it currently exists. Introduce the problems that have motivated the development of the new system.

## Justification for and Nature of Changes

Describe shortcomings of current system/situation, which helps to bridge the gap between sections 3 and 5. User needs are identified.

## Concept for Proposed Environment

Describe the new system that is a result of the justification of changes and user needs in section 4.

## Operational Scenarios

Document operational scenarios/use cases for the new system. Use cases provide a description of how the new system should operate.

## Summary of Impacts

Describe the operational impacts of the new system on users, developers, maintainers, and other agencies and stakeholders.

## Analysis of the Proposed System

Provide an analysis of the benefits, limitations, advantages/disadvantages, and alternatives/trade-offs considered.



## Task 2

# ConOps Schedule

2021

2022

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

Jan

Feb

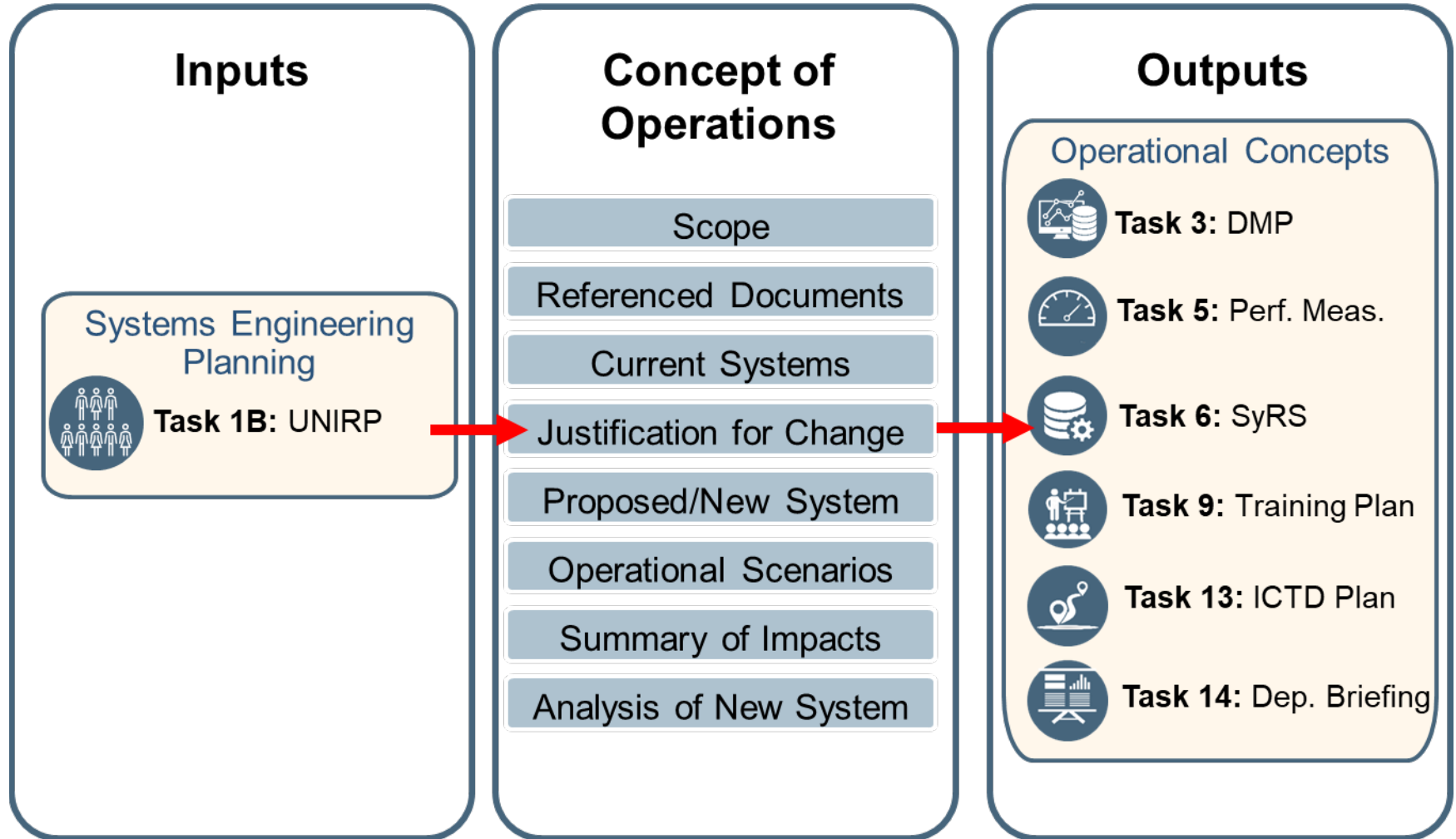
|         |                       |                    |  |  |  |  |  |                              |  |  |  |  |
|---------|-----------------------|--------------------|--|--|--|--|--|------------------------------|--|--|--|--|
| Task 1  | User Needs            | Project Management |  |  |  |  |  |                              |  |  |  |  |
| Task 2  | Concept of Operations |                    |  |  |  |  |  |                              |  |  |  |  |
| Task 3  |                       |                    | Data Management Plan                           |  |  |  |  |                              |  |  |  |  |
| Task 4  |                       |                    | Safety Plan                                    |  |  |  |  |                              |  |  |  |  |
| Task 5  |                       |                    | Performance Measurement                        |  |  |  |  |                              |  |  |  |  |
| Task 6  |                       |                    | System Requirements                            |  |  |  |  |                              |  |  |  |  |
| Task 7  |                       |                    | Tech Readiness                                 |  |  |  |  |                              |  |  |  |  |
| Task 8  |                       |                    |  |  |  |  |  | Human Use Approval           |  |  |  |  |
| Task 9  |                       |                    |  |  |  |  |  | Training Plan                |  |  |  |  |
| Task 10 |                       |                    | Institutional, Partnership, and Financial Plan |  |  |  |  |                              |  |  |  |  |
| Task 11 |                       |                    |  |  |  |  |  | Outreach Plan                |  |  |  |  |
| Task 12 |                       |                    |  |  |  |  |  | SEMP                         |  |  |  |  |
| Task 13 |                       |                    |  |  |  |  |  | Deployment Plan              |  |  |  |  |
| Task 14 |                       |                    |  |  |  |  |  | Deployment Readiness Summary |  |  |  |  |

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U.S. Department of Transportation  
ITS Joint Program Office

# ConOps Interdependencies



# Task 2 Deliverables

- USDOT requires each site to use the template provided

| ID       | BAA Section | Task 2: Concept of Operations (ConOps)         | Due Date        | Format | Site Specific Date |
|----------|-------------|--|-----------------|--------|--------------------|
| P1T02D1  | 5.2         | Stakeholder ConOps Review Panel Roster (Draft) | award +8 weeks  | Word   |                    |
| P1T02D2  | 5.2         | Needs Summary (Draft)                          | award +8 weeks  | Word   |                    |
| P1T02D3  | 5.2         | Stakeholder ConOps Review Panel Roster (Final) | award +10 weeks | Word   |                    |
| P1T02D4  | 5.2         | Needs Summary (Final)                          | award +10 weeks | Word   |                    |
| P1T02D5  | 5.2         | ConOps (Draft)                                 | award +13 weeks | Word   |                    |
| P1T02D6  | 5.2         | ConOps Walkthrough Briefing Deck               | award +13 weeks | PPT    |                    |
| P1T02D7  | 5.2         | ConOps Comment Resolution Report (Draft)       | award +15 weeks | Word   |                    |
| P1T02D8  | 5.2         | ConOps (Final)*                                | award +18 weeks | Word   |                    |
| P1T02D9  | 5.2         | ConOps Comment Resolution Report (Final)       | award +18 weeks | Word   |                    |
| P1T02D10 | 5.2         | ConOps Webinar (Public)                        | award +21 weeks | PPT    |                    |

\*508 Compliant Deliverables

# ConOps Sections



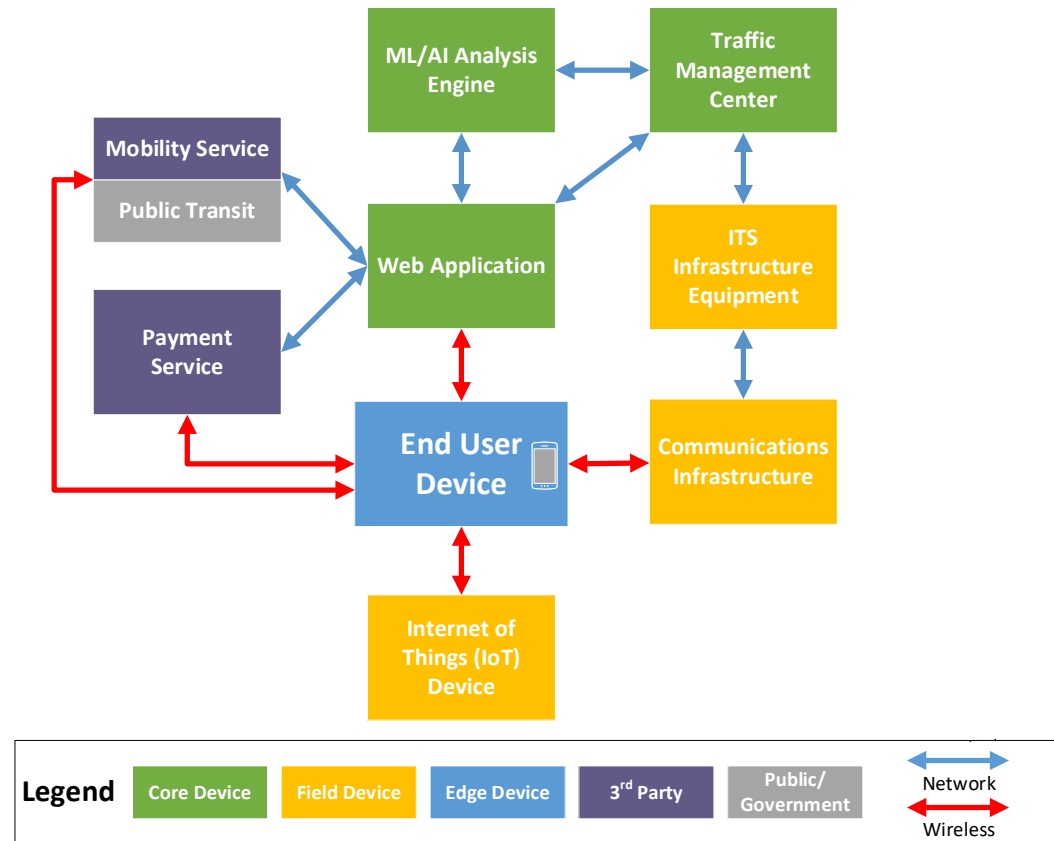
# Section 1: Scope

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- Provides introduction and overview of the ConOps.
- Subsections:
  - 1.1 - Background
    - Introduce the USDOT ITS4US Program and your initial concept
    - Define “underserved” communities for your specific project
    - Include glossary and acronym list
  - 1.2 - Document Overview
  - 1.3 - System Overview

# Subsection 1.3: System Overview

- Introduce purpose of new system
- Describe the high-level components of the deployment / new system
- Develop a context diagram depicting the high-level components and their relationship



Generic Context Diagram

# Section 3: Current System and Situation

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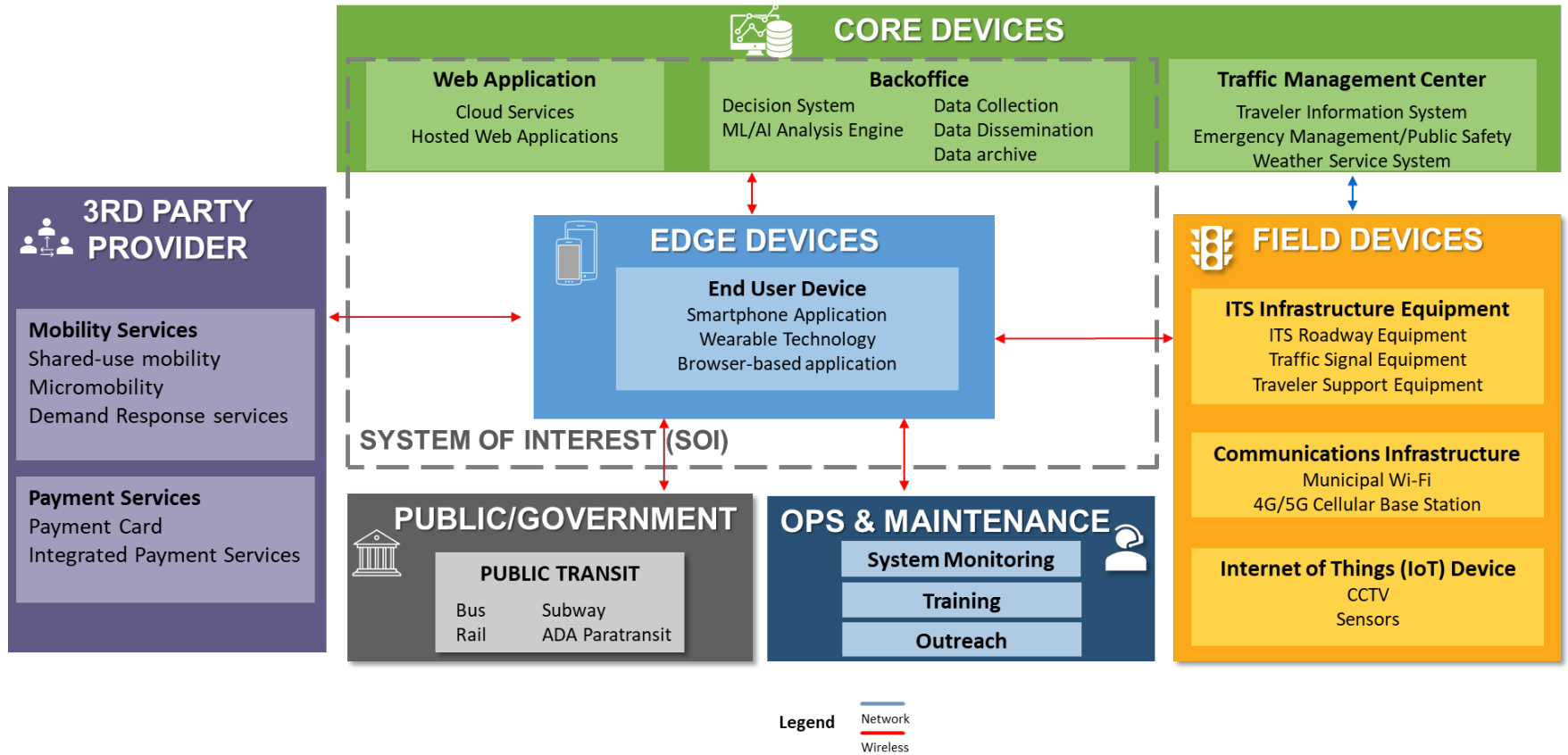
- Describes the current system (or lack of a system). This section begins to define the problem by showing readers how the current system operates.
- Subsections:
  - 3.1: Background and Scope
  - 3.2: Description of the Current System and Situation
  - 3.3: Current System Stakeholders
  - 3.4: Support Environment
  - 3.5: Modes of Operation for Current System
  - 3.6: Operational Policies and Constraints

# Section 3.2: Description of the Current System and Situation

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- This section should describe aspects of the current system including:
  - The operational environment
  - Major system components and features
  - Interfaces to external systems
  - Context Diagram
  - Performance characteristics
  - Requirements for safety, security etc.
  
- If no current system exists, the section should describe the current environment and motivation for a new system.
  - Describe the stakeholders involved and what they are doing currently without any system

# Context Diagram Example



## Section 3.3: Current System Stakeholders

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- Identify all the stakeholders and users involved in the operation, usage, and maintenance of the current system and mapping their roles and responsibilities to the current system(s).
- The identified system stakeholders should all be involved at some level in the creation of the ConOps.



Regional  
Commuter  
Rail Agency



Local DOT



Transit  
Agency



End Users



Paratransit  
Provider

# Section 3.4: Support Environment

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- Describe the support environment of the current system. Describe other supporting systems such as:

Communications  
Networks



Maintenance  
and Support  
Facilities and  
Systems



Enterprise  
Technology  
Services



Other  
Supporting  
Tools,  
Resources,  
or Systems



# Section 3.5: Modes of Operation

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- Describe the modes of operation of the current system
- The section should at least cover:
  - **Normal** mode – normal daily operation of the system
  - **Degraded** mode – when a part or component of the system is offline, what happens to the working and offline components?
  - **Failure** mode – describe what happened when the entire system goes offline. How is the system restored? What are the expected performance metrics?



# Section 3.6: Operational Policies and Constraints

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- Describe policies and other factors that constrain current system.
- Examples include:
  - Hours of operations
  - IT-related policies
  - Manpower limitations
  - Financial limitations
  - Service Level Agreements
  - Other Contractual Agreements



## Section 4: Justification for Changes and Description of Changes

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- Describes shortcoming(s) of current system as depicted by the system stakeholders. These shortcomings are then used for the justifications of the new system.
- Subsections:
  - 4.1: Justification of Changes
  - 4.2: Description of Desired Changes
  - 4.3: Priorities Among Changes
  - 4.4: Changes Considered but not Included
  - 4.5: Assumptions and Constraints

# 4.1: Justification of Changes

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- Provide justification for a new system by:
  - Summarizing **new or modified aspects** of the user needs, missions, objectives, environments, interfaces, personnel, or other factors that require a new or modified system
  - Summarizing the **deficiencies or limitations** of the current system(s) that make it unable to respond to new or changed factors
  - Explaining **why a new system should be developed to meet this opportunity** for underserved communities, describing the rationale behind the decision to modify the existing system and explain why new functionality is needed.

## 4.2: Description of Desired Changes

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- Capture the user needs of the new system, summarizing the capabilities, functions, interfaces, and other changes to fully answer the justifications for changes. Well-written user needs have the following characteristics:
  - **Uniquely Identifiable.** Each need shall be **uniquely identified** (i.e., each need shall be assigned a unique number and title)
  - **Major Desired Capability (MDC).** Each need shall express a **major desired capability** in the system, regardless of whether the capability exists in the current system or situation or is a gap
  - **Solution Free.** Each need shall be **solution free**, thus giving designers flexibility and latitude to produce the best feasible solution
  - **Capture Rationale.** Each need shall capture the rationale or intent as to **why** the capability is needed in the system

# User Need Example

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Uniquely Identified



Major Desired Capability



Capture Rationale



Solution Free

**2.6.2.1 Transferring from subway platform to other modes.** Transferring from subway platform to shared use service boarding location transit users need to navigate from the subway platform to the shared services hailing location in order to allow users to transition between modes and continue on their trip.

# User Need Examples

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Uniquely Identified



Major Desired Capability



Capture Rationale



**2.6.2.1.1 Accurate positioning inside buildings.** Transit users with disabilities need to be able to accurately locate their position within buildings, in order to navigate through a transit station and determine their exact location in the environment.

Uniquely Identified



Major Desired Capability



Capture Rationale



**2.6.2.1.2 Precise localization inside buildings.** Transit users with disabilities need to be able to precisely locate their position with respect to other features such as doorways and escalators, in order to navigate through a transit station and identify building features and points of interest.

Solution Free

## 4.3: Priorities Among Changes

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- Each user need should be classified as:



Essential



Desirable



Optional

- The section should also give justification as to why a need falls within the given category

## 4.4: Changes Considered but not Included

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- Describe any features, functions, use cases, or users that were considered for the new system
- Provide explanation to readers and users to understand why an issue may not be addressed by the system
- Provide historical reference throughout the project to document why particular aspects may have been not included in the system at the beginning.



## 4.5: Assumptions and Constraints

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- Describe assumptions and constraints in the current system
  - Assumptions may be any conditions which are accepted to be true, for example the system will need to double capacity in two years.
  - Constraints are external requirements, limits or other factors that may impact the development and operation of the system
- Examples of constraints:



Standards



Rules



Regulations



Processes



Policies

# Section 5: Concepts for the Proposed System

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- Describe new system
- Subsections:
  - 5.1: Background and Scope
  - 5.2: Description of the Current System and Situation
  - 5.3: Stakeholders for the Proposed System
  - 5.4: Support Environment
  - 5.5: Modes of Operation for Proposed System
  - 5.6: Operational Policies and Constraints
- These subsections follow the same structure as section 3 except the **proposed system** should be explained.

## 5.2: Description of the Proposed System

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- Describe aspects of the new system including:
  - The operational environment
  - Major system components and features
  - Interfaces to external systems
  - Context Diagram
  - Performance characteristics
  - Requirements for safety, security etc.
- This section can be broken down into subsections to logically explain the system. The context diagram can help to set up this sub system structure.

## 5.3: Stakeholders for Proposed System

- Identify all the stakeholders and users that may be involved in the operation, usage, and maintenance of the **proposed system** and mapping their roles and responsibilities to the **proposed system(s)**.
- The identified system stakeholders should all be involved at some level in the creation of the ConOps
- Note: The remaining subsections apply to the **proposed system** following the same structure as the existing system described in Section 3.



Regional  
Commuter Rail



Local  
DOT



Transit  
Agency



End  
Users



Paratransit  
Provider



Universities



Shared  
Mobility  
Providers



Advocacy  
Orgs.

# Section 6: Operational Scenarios

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- Describes operational scenarios or uses cases for the proposed system.
- Should provide a step-by-step description of how the proposed system should operate
- The scenarios should depict all aspects of the system to show how users will interact with the system
- Scenarios should cover positive and negative (failure or error) scenarios.
- The scenarios should be comprehensive to cover all major capabilities and user classes but do not need to be exhaustive of every detail of the system.

# Example Operational Scenario

|                          | Integrating Deployment Solutions Across Multiple Trip Segments  |
|--------------------------|---|
| <b>Short Description</b> | In this use case, the user disembarks from the subway and enters an underground transit station where there is little to no GPS signal. The user needs help with localization and navigation through the underground transit station to the exit. Upon exiting the subway station, the user must locate the pay station and then locate a ride share service to complete the final leg of their trip. |
| <b>Goal</b>              | The goal of this use case is to illustrate how integrating deployment solutions across multiple trip segments such as indoor navigation, vehicles and mode transfers/payment stops and stations, and connecting and completing trip segments, can be obtained to allow a traveler seamless transition. It also illustrates how enabling components can be a technology or a service.                  |

# Example Operational Scenario (cont.)

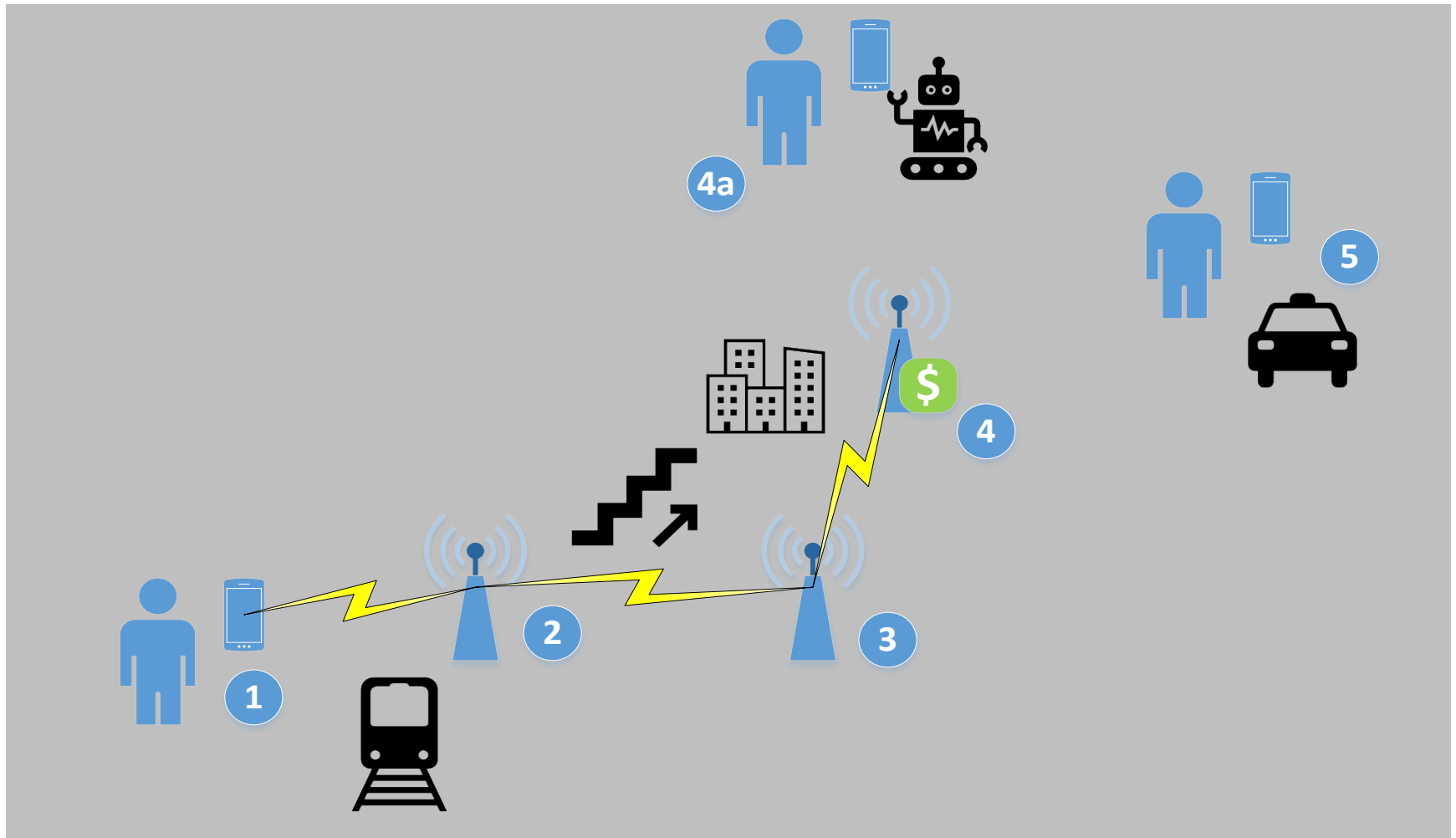
|                                | Integrating Deployment Solutions Across Multiple Trip Segments  |
|--------------------------------|---|
| <p><b>Constraints</b></p>      | <ul style="list-style-type: none"> <li>• A significant constraint in this use case for all underserved population is the lack of positional accuracy when the user is underground.</li> <li>• Another constraint for all underserved populations is the need for the solution to be integrated across each trip segment</li> <li>• There are also constraints that should be considered for the underserved population, for example, individuals with visual impairments may need additional assistance navigating the underground facility and a visual solution may not be sufficient. Individuals with a mobility impairment, may need specific routes in the facility to navigate such as the use of elevators or elevated platforms. The intended user(s) ability to perform the actions in this use case must be considered.</li> </ul> |
| <p><b>Geographic Scope</b></p> | <p>Underground transportation facilities with multiple tracks for subways, limited escalators and elevators, limited lateral space, and potentially long corridors. Accessibility features may also be limited, GPS and phone signal are limited, and the facilities could be subject to heavy foot traffic during all hours.</p>   |

# Example Operational Scenario (final)

|               | Integrating Deployment Solutions Across Multiple Trip Segments   |
|---------------|--|
| <b>Actors</b> | <ul style="list-style-type: none"><li>• Wayfinding and localization application</li><li>• Trip Planning Applications</li><li>• Ride-share service</li><li>• Payment Application</li><li>• Application Programming Interface (API) to integrate and connect applications</li><li>• Smart Phone with IOT localization device</li><li>• Bluetooth Beacons (waypoints)</li><li>• Transit Agency</li><li>• Underserved Population User/Traveler</li></ul> |



# Operational Scenario Illustration



# Operational Scenario

| <i>Item</i>          | <i>Details</i>   |
|----------------------|--|
| <b>Preconditions</b> | <ol style="list-style-type: none"> <li>1. The underground transportation facility has Bluetooth enabled beacons placed throughout the facility to provide location and navigation information.</li> </ol>  |
| <b>Main Flow</b>     | <ol style="list-style-type: none"> <li>1. User disembarks from the subway into an underground station. Upon exiting the train, the user accesses the API that integrates all travel solutions together.</li> <li>2. The API accesses the localization and navigation application that shares the user's location with the nearest Bluetooth beacon.</li> <li>3. Using GPS provided by the beacons, the application provides a path to the station exit where the ride-share will be picking up the user. The path the application gives is based on predefined preferences from the user such as the use of escalators, stairs or elevators, front of the train or the back, how to pay, best route based on mobility factors or limitations, etc.</li> <li>4. Upon approaching the pay station, the API automatically pulls up a touch-and-go payment service allowing the user to pay for the subway trip without opening a different application or paying with a transit fare card. Because the user was able to pre-program his trip within the app, the application automatically hailed a ride-share service in the area when he reached his correct stop.</li> <li>5. Upon exiting the underground facility, the ride-share is waiting for the user</li> </ol> |

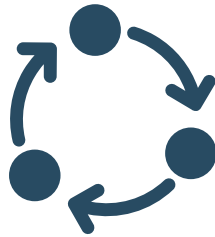
# Operational Scenario (cont.)

| <i>Item</i>                     | <i>Details</i>  |
|---------------------------------|---|
| <b>Alternate Flows</b>          | 4a. Instead of the API providing a path to the nearest exit, it could call an accessibility service (human helper/assistant?) to help the user through the underground station  |
| <b>Post-conditions</b>          | 1. The Trip planning application in the user's phone alerts a legal guardian or caretaker of a successful trip or if the user has traveled of the predetermined route.  |
| <b>Information Requirements</b> | <ul style="list-style-type: none"> <li>• Bluetooth Beacon: location, status (e.g. operating, receiving, transmitting)</li> <li>• API: location, status, route preferences, payment preferences</li> <li>• Traveler Information Advisories, route detours, maintenance, unavailable accessibility points</li> </ul>  |
| <b>Related User Need</b>        | <p>List user needs this use case meets here:</p> <ul style="list-style-type: none"> <li>2.6.2.1 Transferring from subway platform to shared use service boarding location               <ul style="list-style-type: none"> <li>2.6.2.1.1 Accurate positioning inside buildings</li> <li>2.6.2.1.2 Precise localization inside buildings</li> <li>2.6.2.1.3 Transit Station Information</li> </ul> </li> </ul> |

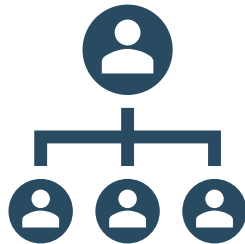
# Section 7: Summary of Impacts

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- Describe the impacts of the new system on the users, developers, maintainers, and other agencies and organizations involved with the system



Operational  
Impacts



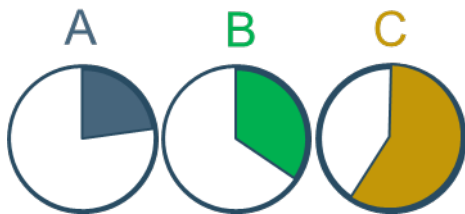
Organizational  
Impacts



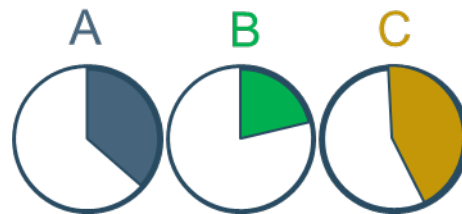
Impacts During  
Development

# Section 8: Analysis of the Proposed Systems

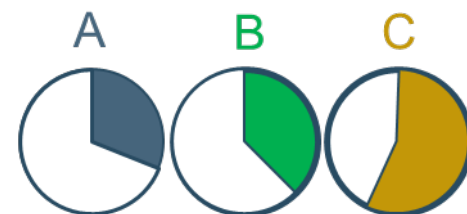
- Describe and focus on the proposed system and the benefits, limitations and/or disadvantages of the system
- Alternatives and Trade-Offs Considered
  - Analyze alternatives considered at the ConOps phase that are not part of the project
  - Build upon Section 4.4 and discuss the trade-offs and document the decisions made for each alternative



Travel Time Savings



Impact on Existing System



Implementation Costs

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# ConOps Walkthrough

# ConOps Walkthrough Overview

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- The ConOps walkthrough is the event when stakeholders from across the different stakeholder groups can get together to discuss use cases and user needs
  - These events are critically important to gaining consensus and clarity on the user needs and ensure all stakeholders have a common understanding of the proposed system
- During the walkthrough you will:
  - Review System Context Diagrams
  - Review All Use Cases
  - Review All User Needs
- Having discussions among the stakeholder groups is the point of this process and a good thing!

# ConOps Walkthrough Expectations

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- Sites should plan for 3 days of ConOps Walkthrough
  - Should be virtual based on current timeframe for walkthroughs
  - Accommodate multiple time zones if necessary (e.g. 11 AM EST – 5 PM EST)
- Sites should try and maximize stakeholder group participation
  - Try to get 1 or 2 stakeholders from each stakeholder group
  - It is acceptable to schedule certain reviews to accommodate stakeholder participation
  - It is important that key stakeholders participate in the reviews where their user needs are being addressed
- Recommend Scheduling the ConOps Walkthrough for roughly 1.5-2 weeks after Draft ConOps release
  - Allows stakeholders to review and bring their comments to the walkthrough
- ConOps Walkthrough Briefing Deck should guide present the Context Diagrams, Use Cases and User Needs



# Resources

# Useful References

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## ITS4US ConOps Template

### IEEE Resources:

- IEEE 1362-1998 - IEEE Guide for Information Technology - System Definition - Concept of Operations (ConOps) Document
- IEEE 1028-2008 - IEEE Standard for Software Reviews and Audits
- 29148-2011 - ISO/IEC/IEEE International Standard - Systems and Software Engineering -- Life Cycle Processes --Requirements Engineering
- These versions or later revisions are all acceptable for use

### FHWA SE Resources:

- [Systems Engineering for Intelligent Transportation Systems](#) - provides an introduction to systems engineering and leads the reader step by step through the project life cycle and describes the systems engineering approach at each step.
- [Systems Engineering Guidebook for Intelligent Transportation Systems](#) - provides a more in-depth reference for ITS practitioners applying systems engineering to plan, implement, manage, and operate ITS.
- [Applying Scrum Methods to ITS Projects](#) – provides information for those interested in learning about Scrum Methods, one of the Agile Methodologies, and how to incorporate Scrum into ITS project development. Also includes links to Agile resources.

# Stay Connected

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**For more information please contact:**

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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](https://www.its.dot.gov/its4us/its4us_faq.htm)

Any questions?

