

# Phase 1 User Needs Identification and Requirements Planning (UNIRP)

## California Association for Coordinated Transportation ITS4US Deployment Project

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# 1. Introduction

The User Needs Identification and Requirements Planning Document (UNIRP) defines the processes that will be used to identify user needs and system requirements in the Concept of Operations to be delivered in Task 2, and the Systems Requirements Specifications document to be delivered in Task 6. This document will also form the foundation of the Systems Engineering Management Plan (SEMP) delivered in Task 12.

The identification of user needs and requirements must occur early enough in the project to inform design and development decisions. As such, the purpose of the UNIRP is to propose an expedient, thorough, and reliable approach to that process. The SEMP will also include content from sections in the UNIRP, as well as from other tasks' sections to address remaining systems engineering processes.

The user needs and system requirements defined through the processes described in this report will provide for the project design space through a systems engineering approach, that sets the project up to pursue agile design and development processes during the course of product implementation during Phase 2. User needs will be used during the course of the Concept of Operations (ConOps) development to justify the changes to the current system of trip planning practices, and a new system will be proposed to meet those defined user needs. From that system design, functional, performance, interface, security, and physical requirements will be defined and linked to those user needs to support the development, deployment, and maintenance of the system. Each of these user needs and system requirements will be subject to configuration control as described this report.

## 1.1. Project Background

*Plan, book, and pay for demand-responsive transit agencies in CA, OR, and WA* is a coordinated effort of CALACT and partners representing regulators, operators, private industry, advocates, and riders across the three states of Washington, Oregon, and California, to improve the user experience and cost efficiency of demand responsive transit for riders at agencies throughout the region. The project seeks to deliver the following outcomes to the trip planning user experience:

- Understand available demand-responsive options, including their eligibility requirements
- Book ADA paratransit and other demand-responsive trips for same-day service through ubiquitous software applications and hardware devices
- Pay any required fares with contactless cards or linked payment accounts
- Ubiquitous data for text-to-speech annunciation and multilingual translation, and other accessibility improvements

During the course of Phase 1, the CALACT project will investigate user needs and system requirements, and plan the investments that will be made should the project continue into Phases 2 and 3. Many potential solutions have been identified within the project proposal, which are under consideration:



- New data specifications and specification extensions, such as
  - The broad adoption of GTFS-flex, GTFS-pathways, GTFS-TextToSpeech
  - The definition of new GTFS extensions for eligibility, vehicles
  - The definition of new specifications for Booking and Payment APIs
- Open source software development, such as
  - A demand-response transit booking application
  - A transit agency directory application based on open data
  - Common tools for transit equity and accessibility analysis
- Software best practices definitions, such as
  - Standards for booking software features
  - Standards for trip planning application accessibility

*Plan, book, and pay for demand-responsive transit agencies in CA, OR, and WA* is one of five Complete Trip ITS4US Deployment Program projects (currently in Phase 1) that USDOT ITSJPO has selected to showcase innovative business partnerships, technologies, and practices promoting independent mobility for all travelers regardless of location, income, or disability.

Project partner (subcontractor) organizations include:

- Oregon Department of Transportation (ODOT)
- Washington Department of Transportation (WSDOT)
- California Department of Transportation (Caltrans)
- Washington State Transit Association (WSTA)
- Trillium, an Oregon small business
- Compiler LA, a California small business
- Tamika L. Butler Consulting, a California small business
- Mark Wall Associates, a California small business
- Estolano Advisors, a California small business
- California Partners for Advanced Transportation Technology at UC Berkeley
- MobilityData IO, a Canadian nonprofit
- Transit, a Canadian private corporation registered for business in the US
- Navilens, a Spanish private corporation registered for business in the US
- Google, an American public corporation (unfunded).

## 1.2. Intended Audience

The intended audience of this document is the CALACT team, including all CALACT subcontractors, as well as the USDOT program management team. Academic and practitioner stakeholders who may find this document useful are considered as well.

## 1.3. User Needs and Requirements Update Process

Insights gained as we identify user needs and system requirements may change our approach to the identification process itself. Therefore, the project team will evaluate and adjust the User Needs Identification and Requirements Planning (UNIRP) report on an ongoing basis to incorporate those insights.

Ongoing evaluation of how later tasks inform processes already established in the UNIRP will occur throughout the course of Phase 1 as part of the communication pipeline within the PLC, but likely between task leads of tasks 1B, 2, 6, and 12. If a partner determines that the UNIRP requires updating, they will make a request to the SDL, who will confirm with PMT, and then coordinate and direct the change to the document. Systems Development Lead (SDL) who will then coordinate and direct updates to this document. Changes to the UNIRP will be announced to the PLC.

User Needs and System Requirements defined through the processes identified in this document may also be changed during the course of the project, based on new information gathered and the lessons of the design, build, and test phase of the project in Phase 2. The PLC will act as the de facto Configuration Management Board, under the primary leadership of the SDL, coordinating with Task Leads and Product Managers for each respective Task or Product wherein a change to User Needs or System Requirements has been proposed. Any proposed change to a User Need or System Requirement will be precisely specified by the Task Lead or Product Manager in coordination with the SDL, and the PLC will be informed of the change prior to confirming that change within the ConOps or SyRS, as appropriate. The ConOps and SyRS are both available to all partners, stakeholders, and members of the public through the project drive, as well as through official publication processes.

## 1.4. Applicable Documents

CALACT and partners will use processes identified in the UNIRP in the creation of the following documents:

- Concept of Operations (ConOps)
- System Requirements (SyRS)
- Systems Engineering Management Plan (SEMP)

## 2. User Needs Identification

### 2.1. Introduction to User Needs

User needs serve as the traceable starting point for the systems engineering lifecycle of a project. The original proposal hypothesizes existing gaps in service that affect underserved populations. The project team will develop user needs from stakeholder interviews, assessing:

- a. Whether the system hypothesized in the proposal accurately depicts the current gaps.
- b. Whether there are other gaps not yet identified.

Synthesis of these stakeholder insights will be the primary way user needs are developed. Use Case Decomposition will be used to validate user needs. All user needs will be uniquely identifiable, solution free, express a major desired capability (MDC), and capture a rationale, per the guidance of USDOT ITSJPO.

### 2.2. User Needs Identification Processes

The following sections detail the strategies that will be used to identify user needs throughout this project's lifecycle. User needs identified during the proposal phase of this project are also discussed, as they will serve as the foundation for additional development of user needs.

#### 2.2.1. Previously Identified User Needs

The following table lists the user needs originally identified in the proposal. User needs are categorized by user population (e.g., "People with mobility disabilities").

Note that these user needs are in their original form and thus do not follow the criteria of a "well-written user need" (see section 2.1 of this document) but are included to show the baseline problems the program intends to address. The project team will administer surveys within the context of one-on-one user population interviews to validate and refine user needs. In these surveys, individuals will review the originally identified user needs and evaluate whether they are valid. Users' evaluations will be taken under consideration as the user needs are refined and rewritten in Task 2: Concept of Operations. The project team will ensure user needs are uniquely identifiable, solution free, express a major desired capability (MDC), and capture a rationale, per the guidance of USDOT, ITSJPO. In addition, more user needs may be identified through the strategies outlined in later subsections of Section 2.2.

The user needs originally identified will also be revised to follow the proper form of user needs, under the direction of the CDL and SDL during the development of the ConOps. In the table below, after each user need from the original project proposal, a currently revised form demonstrates progression towards the user needs to be derived from the originally identified

needs. These user needs earlier identified will be presented to users and user groups along with additional information and questions to develop from these starting user needs the specific user needs and functions necessary to fulfill these general user needs.

User Population	User Needs
People with mobility disabilities	<ul style="list-style-type: none"> <li>• ADA paratransit and other demand-responsive services are often focused on people with mobility disabilities because walking or rolling to a bus stop is a considerable mobility challenge, but these services are not represented in trip planners. <ul style="list-style-type: none"> <li>○ The user must be able to discover and book demand responsive trips within online/mobile trip planners.</li> </ul> </li> <li>• Information about whether a specific mobility device can be loaded onto a vehicle, and whether there is occupancy for that device, is currently not provided by trip planners. <ul style="list-style-type: none"> <li>○ The user must be able to tell whether they will be able to board the vehicle that will serve their trip, along with their mobility device and other equipment or items they intend to bring along on their trip.</li> </ul> </li> <li>• Many bus stops and stations have both accessible and inaccessible routes, but trip planners do not typically provide wayfinding information that allows users to identify the accessible route. <ul style="list-style-type: none"> <li>○ The user must be able to understand the pathways they will use to get to their boarding location, between transfer</li> </ul> </li> </ul>

	<p>points, and to their destination which are accessible to them.</p>
<p>People with vision disabilities</p>	<ul style="list-style-type: none"> <li>• Many abbreviations or other text that cannot be read out loud cannot be delivered by annunciation software on mobile and other devices.             <ul style="list-style-type: none"> <li>○ The user must be able to hear via text annunciation all information necessary to the trip planning experience without some text being garbled or incoherent.</li> </ul> </li> <li>• Complete route information is insufficiently represented in datasets with this information often available only in physically posted signs near or in stations.             <ul style="list-style-type: none"> <li>○ The user must have access to any alerts or directions through audio</li> </ul> </li> </ul>
<p>People with cognitive and developmental disabilities</p>	<ul style="list-style-type: none"> <li>• Trip planning data often lacks metadata and cosmetic information (such as route shapes) or alternatively includes overly verbose data that prevent the easy understanding of transit service options.             <ul style="list-style-type: none"> <li>○ The user must be provided trip planning data in a simple format that does not rely on more words than necessary or a cluttered interface which contains excessive information.</li> </ul> </li> <li>• Signage is designed for users with a complex understanding of written English.             <ul style="list-style-type: none"> <li>○ The user must be provided visual and audio information that does not require a complex English vocabulary.</li> </ul> </li> </ul>

People with hearing disabilities	<ul style="list-style-type: none"> <li>• Visual wayfinding information is not provided by apps to give riders clear directions within station facilities and information to look for at bus stops. <ul style="list-style-type: none"> <li>○ The user must have access to information about wayfinding signs prior to arrival at the station or pickup/drop off location so that they can look out for that information.</li> </ul> </li> <li>• Service alerts are often offered only as verbal announcements onboard buses or trains. <ul style="list-style-type: none"> <li>○ The user must have access to all information presented to riders in a visual or text media.</li> </ul> </li> </ul>
Older Adults	<ul style="list-style-type: none"> <li>• Touch interfaces such as smartphone apps are not designed for users with limited dexterity. <ul style="list-style-type: none"> <li>○ The user must be provided an interface which does not require a high degree of manual dexterity to operate.</li> </ul> </li> <li>• Interfaces are not designed for users with limited experiences in the form factor (e.g. website, smart phone). <ul style="list-style-type: none"> <li>○ The user must be provided with an interface which does not require experience with similar interfaces to operate.</li> </ul> </li> </ul>
Low-income populations	<ul style="list-style-type: none"> <li>• Wealthier agencies receiving more local taxes can purchase more complex technical systems. <ul style="list-style-type: none"> <li>○ The user must have access to trip planning systems regardless of the technical sophistication and level of financial resources of the transit system the user is accessing.</li> </ul> </li> <li>• Low-income workers with multiple jobs, childcare, without time or skills</li> </ul>

	<p>to embark on transit research projects have less time to invest in finding and learning about transit technology tools.</p> <ul style="list-style-type: none"> <li>○ The new user must be able to use the system easily with minimal guidance.</li> <li>• Fare information is not available through easy demand-responsive trip planning, preventing low-income riders from budgeting effectively.             <ul style="list-style-type: none"> <li>○ The user must be informed of the cost of the service, whether the service is free, and whether there are ways to reduce the cost of the trip and how to access those price reductions, so that the user can spend their money effectively.</li> </ul> </li> <li>• Demand-responsive services may require a credit card that a low-income person is less likely to have.             <ul style="list-style-type: none"> <li>○ The user must be able to pay a fare using a payment media that they have routine access to rather than need a special form of payment media.</li> </ul> </li> </ul>
<p>Rural residents</p>	<ul style="list-style-type: none"> <li>• Lack of data on rural routes, lack of web available information on rural routes as a result of agency funding.             <ul style="list-style-type: none"> <li>○ The user must be able to discover all trips where they're travelling from or to.</li> </ul> </li> <li>• Rural services are more often demand-responsive or deviated-fixed routes, which are not covered by current transit rider apps.</li> </ul>

	<ul style="list-style-type: none"> <li>○ The user must be able to discover and book demand responsive trips within online/mobile trip planners.</li> </ul>
Veterans	<ul style="list-style-type: none"> <li>• They do not service the diverse array of focused services available to veterans and their families, or special pricing related to veteran status. <ul style="list-style-type: none"> <li>○ The user must have access to information about services or prices geared specifically towards veterans within online and mobile trip planners.</li> </ul> </li> </ul>
People with limited English proficiency	<ul style="list-style-type: none"> <li>• Signage is designed for users with a complex understanding of written English.</li> <li>• Interfaces and applications for trip planning and navigation rely on written or spoken communication without quality visual information design. <ul style="list-style-type: none"> <li>○ The user must have access to all information within text and visuals that do not require a complex understanding of English to be understood.</li> </ul> </li> <li>• Interfaces are not designed to be translated (known as internationalization in software development). <ul style="list-style-type: none"> <li>○ The user should be able to translate any written text to their preferred language.</li> </ul> </li> </ul>

### 2.2.2. Stakeholder Engagements

Engagement of stakeholder populations affected by the work of this project is critical to identify user needs and evaluate whether this program properly addresses those user needs.

Stakeholder engagement, therefore, will take place in the context of the establishment of stakeholder subcommittees. Stakeholder Subcommittees are groups of individuals—organized by a Subcommittee Chair—which convene at their own volition and at the request of the Project Leadership Committee (PLC) or Project Management Team (PMT) to provide feedback regarding the project process and outcomes. A number of project partners including ODOT, WSTA, Mark



Wall Associates, and Tamika L. Butler Consulting will coordinate initial outreach of and manage ongoing engagement with the various stakeholders. The six Stakeholder Chairs will bear most of the responsibilities respective to the subcommittee they chair, mainly in serving as the subcommittee's representative point-of-contact. Given the geographical scope of this project, and the uncertainty brought with the COVID-19 Pandemic, subcommittees will convene primarily through virtual meetings, but subcommittee members are free to engage with the project team through other means of communication and in person (as circumstances allow) on an *ad hoc* basis.

Subcommittees are organized around each of the specific disadvantaged communities, the needs of which the program has committed to address, or which may be affected by the technologies developed. All individuals who contribute their time and labor to the project must be properly compensated, and since subcommittee chairs will provide essential labor to the project, they will be paid as consultants. Other subcommittee members will be compensated for their time as well, on a less formal basis, typically through a gift card delivered to them via email.

Thus, subcommittees will cover several communities identified in the ITS4US BAA and others identified by the project team, each with a subcommittee chair who is a member of one of the disadvantaged communities represented and a paid consultant to the project. Subcommittees will also include members of organizations who represent these communities.

The proposed subcommittees, with communities they represent are as follows:

- Specialized Transportation Operators subcommittee
  - Operator staff
  - Veteran access
  - Non-profit transit
  - Specialized operator technology vendor
- Disability and Access subcommittee
  - Vision-disability access
  - Hearing-disability access
  - Cognitive and developmental disability access
  - People with mobility disabilities
  - Older adult access
- Low income and unbanked communities subcommittee
  - Low-income riders
  - Houseless riders
  - Booking and payment
- Rural and Tribal subcommittee
  - Tribal transit
  - Rural transit
  - Small urban
  - Intercity transit
  - Small operator technology vendors
- Safe and inviting transit subcommittee (two chairs)
  - Black and POC riders
  - Limited-English proficiency
  - Farm worker concern
  - Women and non-binary riders
  - Recently incarcerated riders

- Children and younger riders

The six subcommittee chairs will be members of a disadvantaged group the stakeholder subcommittee represents and will be paid contractors to the project who are not already a partner. Depending on the needs of the project, the availability of new partners, and the budget available for new partners, some portion of the subcommittee chair role may be performed by a technical team member who is not a member of the disadvantaged group but assists the subcommittee in an administrative capacity. Subcommittee members will also be compensated for their time.

Subcommittees will be engaged during the development of user needs, primarily through the stakeholder subcommittee chairpersons designated by the project. These stakeholders will be introduced to the goals of the project and be provided with some example user needs based on the user needs identified in the project proposal and outlined in Section 2.2.1. This context will serve as a basis to further discuss and identify user needs which were not identified previously by the project team. This engagement will be conducted in the context of one-on-one or small group interviews wherein a project team member will administer the User Needs Survey to collect their input. The User Needs Survey will ask open-ended questions and walk through each previously identified user need, asking if the user need exists for the population the stakeholder represents. The survey also asks if there are any other gaps in service not already identified. Feedback collected from the surveys will form the basis for refining user needs during ConOps development.<sup>1</sup> Additionally, the six stakeholder subcommittee chairs will participate in a portion of the ConOps walkthrough to further discuss and understand the user needs which should be captured by the project.

### 2.2.3. Use Case Decomposition

Stakeholder engagement will remain the primary approach the project team will take to identify user needs, and the project team will generate and decompose use cases primarily to validate those user needs. In some cases, Use Case Decomposition may lead to the generation of new user needs not identified through stakeholder engagement.

The project team will take the following approach to Use Case Decomposition. These steps also include a simplified example in italics walking through a Use Case Decomposition:

1. Briefly describe the scenario of the use case.  
*An individual with a mobility disability discovers a dial-a-ride service for ADA qualified persons in their area.*
2. Describe the goals the use case intends to meet.  
*Discoverability for non-fixed-route transit services on commonly used trip planning applications*

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<sup>1</sup> The current User Needs Survey template can be found at the following URL:  
<https://docs.google.com/document/d/1WyrvKH3G51MTp5ptAzciFKyrakGnvjtLOGktneAQHZk/edit#>

3. Describe the constraints that complicate or limit the solution the use case proposes.  
*A user will only be searching for services relevant to their location/eligibility status. For the user to discover the appropriate service, representative data must exist, and the app of their choice must ingest and model it.*
4. Establish the spatial/effective scope of the use case.  
*Anyone with access to the internet could potentially discover the service like this as long as that service has been modeled through this process.*
5. List the actors involved in the solution (e.g., an online database could be an actor for a use case wherein a user must access contact information for a public service).  
*Data that models service information, a trip planning application that ingests that data*
6. List any preconditions that are required for the solution to be implemented. If applicable, break down preconditions by those which are already in place and those which will need to be established.  
*Information about the dial-a-ride service must be up to date and publicly available, the data standard modeling these services must be accepted and used by both producers and consumers for them to appear in trip planning queries*
7. Provide a step-by-step walkthrough applying the solution to the use case (the scenario described in step 1 of Use Case Decomposition).
  1. *An individual with a mobility disability discovers*
    - i. *Popular trip planning apps will ingest and model non-fixed-route services from datasets provided by data producers.*
    - ii. *The user will access their preferred trip planning app and submit a search query for a trip between start and end points.*
  2. *a dial-a-ride service for ADA qualified persons*
    - i. *The data the app consumes and publishes includes information on who the service is for.*
  3. *In their area.*
    - i. *The data includes geographical information on the service boundary.*
    - ii. *Data producers coordinate with all agencies whose services they model to ensure the data is accurate.*
8. If there are multiple ways a single solution can be applied, provide any alternate scenarios.  
*N/A*
9. Describe the outcomes for the user as a result of the applied solution.  
*The user discovers a transit service tailored to their specific needs and is able to plan trips with that service.*
10. Identify which user need the use case applies to and justify that connection. If it does not apply to any user need, determine whether this use case is relevant to the project or if a new user need needs to be written to incorporate the use case.  
*ADA paratransit and other demand-responsive services are often focused on people with mobility disabilities because walking or rolling to a bus stop is a considerable mobility challenge, but these services are not represented in trip planners.*

## 2.3. Concept of Operations Development

This document outlines an approach to user needs, but actual development of user needs will take place in Task 2, Concept of Operations. Key elements of the ConOps, including user needs, will result from stakeholder engagement and will also include high-level stakeholder participation supporting system design. Key Task 2 milestones in establishing the user needs of this program include finalization of the Needs Summary early May 2021 and the completion of the entire Concept of Operations document late June 2021.

The full ConOps development schedule is provided in the next section, 2.3.1.

### 2.3.1. ConOps Development Schedule

The following table shows the schedule for the development of the system ConOps and includes all major milestones.

Deliverable Number	Deliverable Name	Due Date
P1T02D1	Stakeholder Review Panel Roster Draft	4/19/2021
P1T02D3	Stakeholder Review Panel Roster Final	5/3/2021
P1T02D2	Needs Summary Draft	4/19/2021
P1T02D4	Needs Summary Final	5/3/2021
P1T02D5	Concept of Operations Draft	5/24/2021
P1T02D8	Concept of Operations Final	6/28/2021
P1T02D6	Walkthrough Briefing Deck	5/24/2021
P1T02D7	Comment Resolution Report Draft	6/7/2021
P1T02D9	Comment Resolution Report Final	6/28/2021
P1T02D10	ConOps Webinar (Public)	7/19/2021

### 2.3.2. ConOps Walkthrough

The ConOps Walkthrough will be an opportunity to provide key project stakeholders a detailed overview of the project's Concept of Operations and a chance for those stakeholders to provide feedback. Comments gathered during the Walkthrough will be taken into consideration for the final draft of the ConOps document.

The ConOps Walkthrough will take place once the draft ConOps document has been submitted and reviewed, between June 14 and June 16. The precise schedule of this walkthrough will be determined in collaboration with the USDOT COR. Tentatively, the project team expects three sessions over the three day period, each between 2.5 and 4 hours long. The sessions will be facilitated by either the SDL or the CDL. A series of discussions involving the stakeholders and project team members appropriate to each will review the user needs for each set of project concerns. Discussions will be organized around themes which will be determined during the course of the ConOps development, but are expected to include discussions focused on specific stakeholder groups, high-level or priority user needs, and/or expected solution categories.

Participants in the ConOps Walkthrough will include:

- The Project Management Team (PML, CDL and SDL)
- All Task Leads and Product Managers
- All six Stakeholder Committee Chairs, as well as stakeholder representative organizations including advocacy organizations, transit agencies, and technology vendors
- USDOT representatives, including the COR

All participants will be provided with a workbook highlighting user needs and other high-level components of the ConOps prior to the Walkthrough. The Walkthrough workbook will be a 508-compliant Google Slide Deck shared prior to the Walkthrough, downloadable in a PowerPoint format. It will be separated into sections for each discussion, including user needs statements organized by theme and references to other discussion themes that are also relevant to the discussion or in which that user need will also be considered. The SDL will be primarily responsible for the Walkthrough Briefing in collaboration with the CDL, but all Walkthrough participants will be able to comment on the Briefing prior to the ConOps Walkthrough. In the formulation of the Walkthrough workbook any template provided by the USDOT COR will be considered and all necessary components will be incorporated.

## 2.4. Agile Development Considerations

As described in the CALACT proposal for the ITS4US project, our technical team will employ a systems engineering process in the definition of the overall user needs of the system of components to be designed, developed, and deployed in the course of the project. Once the high-level user needs have been defined, an agile development approach will be utilized to design, develop, and deploy individual products that form the components of the overall system.

During Phase 2 work, agile processes will be utilized to iteratively develop products that address those user needs, and lessons learned through feedback from stakeholders including software and data specification users will be incorporated to adapt the specific user needs addressed by each product. This work will be performed within the context and documentation of the systems engineering process for high-level user needs defined in Phase 1. Configuration control of user needs and stories will be maintained within GitHub repositories, which are publicly available.

- Each product being developed will have high-level User Needs defined within the repository as top level issues, and lower-level user needs and related tasks will be defined as related issues.
- Because of the variety of likely products to be developed, the Product Manager for each product will be responsible for working with their product team to define a sprint schedule appropriate to their work. Some products may be developed in sprints as short as two weeks, where others may have sprints as long as four or in some cases possibly six weeks. Sprint schedules will be confirmed with the SDL.
- Work performed during each sprint will be demoed to, at a minimum, the SDL. The SDL will advise on prioritization of issues within the sprint backlog, when support for prioritization is requested by the Product Manager.
- Work performed during each iteration will be reviewed by both the SDL, additional technical team members, and typically, if appropriate, representative stakeholders. The SDL will advise on prioritization of issues within the sprint backlog at this time in light of overall project concerns.
- Work performed during each release will be tested by stakeholders, under the management of the Product Manager and the oversight of the SDL or a delegated project technical team member. The work will also be demoed to the PLC, which will provide comments on outcomes and prioritization of the sprint backlog.
- Configuration control will be maintained by the Product Managers in collaboration with the SDL. Any proposed adjustment to the defined User Needs will be reviewed and enacted by the SDL, who will discuss these changes with the PLC during PLC meetings.

# 3. Requirements Planning

## 3.1. Introduction to Requirements Planning

System requirements define the capabilities a system must have and the constraints within which that system must operate. Identifying and developing solid system requirements is critical to program success and will take place in Task 6. This section details the project team's understanding and approach to system requirements development.

System requirements will be well-written and directly link one or more user need. This traceability will be documented and tracked to ensure the system meets all identified user needs. The Task Lead, with support of the SDL, will use the following criteria (derived from INCOSE Guide for Requirements Tutorial) to ensure system requirements are well-formed:

- **Necessary:** The requirement is an essential capability, characteristic, or quality factor of the product or process. If removed or deleted, it may cause a deficiency that is unable to be fulfilled by other capabilities of the product or process. Two tests of necessary requirements:
  - Must be traceable to higher level requirement
  - If deleted, a major need is not met.
- **Concise:** The requirement simply and clearly states only one need. When a requirement is concise, the statement does not require any explanations, rationale, definitions, or descriptions of system use.
- **Implementation-free:** The requirement does not state how it must be satisfied. The requirement states the desired result in functional and performance terms, not in terms of a solution. Exceptions to this guideline include interface requirements, as specified in Interface Control Documents (ICD). Interface requirements specify what has been previously implemented so that new systems will interface with legacy systems
- **Attainable:** The requirement is achievable at a definable cost. Adequate analysis and trade studies show that the costs are within program cost constraints.
- **Complete:** The stated requirement can stand alone and does not need any further explanation. Each requirement states everything required on the topic and it stands alone when separated from other requirements.
- **Consistent:** The requirement does not contradict or duplicate other requirements. Organizing requirements in accordance with a standard or template facilitates the identification of inconsistencies. It is important to use consistent terminology throughout the requirements document. Therefore, maintaining a glossary of program terms is one effective method for ensuring consistency.
- **Traceable:** Each requirement is traceable to its source (e.g., trade study, ConOps, scenarios, research results, etc.) A requirement also needs to identify related requirements (i.e., parents, children) and requirements that might be impacted by changes to it.
- **Unambiguous:** Each requirement has one interpretation. For a requirement to be unambiguous, the requirement must:
  - Use language that leaves no doubt as to the intended descriptive or numeric value
  - Use common or well-defined words and phrases
  - Avoid using known ambiguous words and phrase (e.g., "capable of...")

- **Verifiable:** Each requirement must be verifiable by inspection, analysis, test or demonstration. A requirement must be stated in measurable terms to be verifiable.
- **Allocate-able:** Requirements should be allocated to the appropriate component within the system hierarchy and/or the appropriate organizational entities (e.g., to develop procedures).
- **Style-compliant:** A style-compliant requirement has the following qualities:
  - Content: Simple sentences, correct grammar and punctuation, positive statements, active voice, use of an appropriate directive verb (explains).
  - Format: Paragraph number, paragraph title, subject, relation, value, capitalization, punctuation, and additional explanatory information in a glossary.

Generally, system requirements will follow the format: [Actor] [Action] [Target] [Constraint] [Localization]. For example:

**The System** [Actor] **will organize** [Action] **vehicle information** [Target] **following a relevant data standard** [Constraint] **for previously specified deployment sites** [localization].

The intention of the CALACT process is to focus on data specifications, open source software, and software best practices solutions which are deployable within the context of the deployment sites to be defined during the project, as well as easily replicable to other deployment sites and regions. Additionally, after defining the high-level system requirements through a systems engineering process, the CALACT project will pursue the finalization of system design and begin development through an agile development process. For these reasons, system requirements defined during Phase 1 Task 6 will identify primarily the high-level requirements of how different system components interact. For example, in order to facilitate the discovery of demand-response transit through customer applications, it will be required for those customer applications to communicate with agency scheduling applications. Specifying with a higher level of detail, without indicating the particular implementation approach and while meeting the other criteria of well-formed systems requirements, will be the focus of Task 6.

## 3.2. Requirement Decomposition

Stakeholder requirements identified in the ConOps will be transformed into technical system requirements using a process that is both iterative and recursive. The Task 6 Lead and SDL will coordinate with product managers to create a table placing all system requirements established at the time of writing into specific categories. The categories will be ordered by their ubiquity within the project scope (as shown below). The table will be included in the Task 6 document and will be updated as new requirements are identified and refined during the course of the project.

System requirements will be decomposed into the following categories:

**A. Functional:** What must the system do to function?

It is expected that every user need will have at least one corresponding functional system requirement.

**B. Performance:** What are the parameters of the system's function? For example, "the system provides an alert **within a specific timeframe.**"



As with functional system requirements, it is also expected that performance system requirements will exist for every user need. This is both to define the scope of the system and ensures that success metrics are quantifiable.

**C. Interface:** How must the system communicate with other systems?

Many of the technologies to be deployed through this project rely on interoperability among systems/components such as data specifications and APIs. Most, but not all, user needs will require this kind of interoperability and accordingly at least one interface requirement.

**D. Security:** What level of security is necessary for specific parts of the system? For example, any data storage requirements for assets like Personally Identifiable Information (PII).

Most of the data produced and maintained as a result of the program is public information, however, user data must be considered in a few circumstances like transactional data, payments, and user accounts. It is these circumstances for which we expect security-based system requirements will be written, but all aspects of the project will be open to security considerations.

**E. Physical:** What are the physical characteristics of the system?

This is the least ubiquitous system requirement type for the CALACT project, as many, if not most, of the technologies the program deploys will be independent of physical infrastructure.

### 3.3. System Requirements Traceability

Every system requirement must be traceable to a specific user need(s). This is to ensure the program outcomes serve all targeted user needs. This traceability will be documented using a Needs-to-Requirements Traceability Matrix (NRTM, see table below). Each Need and Requirement will be assigned a number ID, which will be referenced universally. The System Development Lead (SDL) will coordinate maintenance of the NRTM. Updates to the NRTM due to changes of User Needs and System Requirements will also be managed by the SDL..

**Table 1. Example NRTM**

User Need ID	User Need	Req ID	Requirement

## 3.4. System Requirements Document Development

The following section details the project's approach to System Requirements. Actual System Requirement development will take place in Task 6, Deployment System Requirements, following IEEE Standard 1233-1998. Key Task 6 milestones include finalization of the System Requirements Specification Document late October 2021.

### 3.4.1. SyRS Development Schedule

The following table shows the schedule for SyRS development and includes all major milestones.

Deliverable Number	Deliverable Name	Due Date
P1T06D1	Stakeholder SyRS Review Panel Roster Draft	8/16/2021
P1T06D2	Stakeholder SyRS Review Panel Roster Final	8/30/2021
P1T06D3	System Requirements Specification Document Draft	9/20/2021
P1T06D6	System Requirements Specification Document Final	10/25/2021
P1T06D4	Walkthrough Workbook	9/20/2021
P1T06D5	Walkthrough Comment Resolution Report Draft	10/4/2021
P1T06D7	Walkthrough Comment Resolution Report Final	10/25/2021

### 3.4.2. SyRS Walkthrough

The SyRS Walkthrough will be an opportunity to provide key project stakeholders a detailed overview of the project's System Requirements and a chance for those stakeholders to provide feedback. Any changes to system requirements and user needs determined during Walkthrough discussions will be incorporated into the final draft of the SyRS document.

The SyRS Walkthrough will take place once the draft SyRS document has been submitted and reviewed, expected in the last week of September or first week of October. The schedule of this walkthrough will be determined in collaboration with the USDOT COR. Tentatively, the project team expects two sessions on consecutive days, each between 2 and 4 hours long. The sessions will be facilitated by either the SDL the SyRS task lead. A series of discussions involving the stakeholders and project team members appropriate to each will review the user needs for each

set of project concerns. Discussions will be organized around themes which will be determined during the course of the SyRS development, but are expected to include discussions focused on specific products to be developed by the project.

Participants in the SyRS Walkthrough will include:

- The Project Management Team (PML, CDL and SDL)
- All Task Leads and Product Managers
- All six stakeholder committee chairs, as well as stakeholder representative organizations including advocacy organizations, transit agencies, and technology vendors
- USDOT representatives, including the COR

Prior to the Walkthrough, all participants will be provided with a 508-compliant Google Slide Deck shared prior to the Walkthrough, downloadable in a PowerPoint format, which will serve as a workbook listing all system requirements. The workbook will also include a copy of the NRTM, illustrating traceability to user needs. In the formulation of the Walkthrough workbook any template provided by the USDOT COR will be considered and all necessary components will be incorporated.

## 3.5. Agile Development Considerations

As described in the CALACT proposal for the ITS4US project, our technical team will employ a systems engineering process in the definition of the overall requirements of the system of components to be designed, developed, and deployed in the course of the project. Once the high-level system requirements have been defined, an agile development approach will be utilized to design, develop, and deploy individual products that form the components of the overall system.

During Phase 2 work, agile processes will be utilized to iteratively develop products compliant with those system requirements, and lessons learned through feedback from stakeholders include software and data specification users will be incorporated to adapt the specific system requirements fulfilled by each product. This work will be performed within the context and documentation of the systems engineering process for high-level system requirements defined in Phase 1.

Configuration control of user needs and stories will be maintained within GitHub repositories, which are publicly available.

- Each product being developed will have high-level system requirements defined within the repository as top level issues, and lower-level system requirements including constraints, interface formats and related tasks will be defined as related issues.
- Planning for the sprint schedule will be performed as described in section 2.4, “Agile Development Considerations”
- Configuration control will be maintained by the Product Managers in collaboration with the SDL. Any proposed adjustment to the defined System Requirements will be reviewed and enacted by the SDL, who will discuss these changes with the PLC during PLC meetings.

## 4. Configuration Management

The UNIRP, ConOps, SyRS, and SEMP documents are intended to be adjusted based on lessons learned later in the project. A clearly defined process in place when applying that flexibility will ensure the resulting work based on previously established user needs is not unnecessarily supplanted or undermined. This section lays out that process.

### 4.1. Configuration Management Processes

As user needs and system requirements that need to be changed (whether to be removed, added, or reworked) are identified, proposals for those changes can be brought up during the biweekly PLC meetings, or through email to a PMT member. The SDL or a delegated technical team member will prepare an analysis proposing how the new user need or system requirement will more effectively meet the business case affordably and on schedule. This analysis will be presented to the PLC. The PLC will have an opportunity to discuss the proposed change and offer any feedback. Once a consensus has been reached, the SDL or a team member assigned by the SDL will make any appropriate updates to all relevant documents and inform the COR of those changes. Consensus will be defined as no PLC member vetoing the proposed change, and all PLC members will have the same veto power. If consensus cannot be reached on the proposed change, the SDL will formulate and alternate proposal. Consensus-based decision making is essential to the project approach, and has been demonstrated as effective over 15 years of community management of the General Transit Feed Specification. The use of a veto is not a tool project team members will make lightly, but rather a last resort to prevent a stakeholder group to be significantly harmed.

An ongoing communication pipeline will exist between Product Managers (PMs) and the Task 2 and 6 Leads as work to actualize solutions for user needs-system requirements pairs begins in Phase 2. It will be the responsibility of the PM to determine if any of that work is unaligned with user needs/system requirements. The PM should then bring the topic to discussion at the next PLC meeting so the team can assess whether the work needs to change to fit needs/requirements or if needs/requirements should be reevaluated. Assessment will be carried out through open-ended discussion.

The same process will apply both during the initial development of user needs and system requirements, as well as after the baseline user needs and system requirements. There will be no officially designated configuration control board (CCB), however, the PLC will serve as described above a role very similar to a CCB. Initial user needs and system requirements will be discussed within the PLC at official meetings and through written discussion, which will reach consensus with regard to those user needs and system requirements to be prioritized by the project. After agreement on the baseline user needs and system requirements, the PLC will continue to be the primary venue within which changes are considered. Project documentation will be updated upon any change in user needs or system requirements, in order to ensure that it accurately reflects the system to be implemented.

## **4.2. Authoritative Source of User Needs and Requirements**

The Concept of Operations and Systems Requirements documents will serve as the authoritative source of user needs and system requirements. The two documents will be located in a shared Google Drive folder shared with the project team to ensure broad understanding of user needs and system requirements. These documents will be updated as needed using the approach described in Section 4.1. Upon change of user needs or system requirements, those changes will be reviewed by USDOT and approved through the relevant publication processes, so the project drive and published forms remain in sync.

# Appendix A. Acronyms and Glossary

A/R - Accounts Receivable

BAA - Broad Agency Announcement

CA - State of California

CA PATH - California Partners for Advanced Transit and Highways

CALACT - California Association for Coordinated Transportation

Caltrans - California Department of Transportation

CCPA - California Consumer Protection Act

CDL - Concept Development Lead

ConOps - Concept of Operations

GTFS - General Transit Feed Specification

IEEE - Institute of Electrical and Electronics Engineers

IRB - Institutional Review Board

NIST 800-53 - National Institute of Standards and Technology

PLC - Project Leadership Committee

PML - Project Management Lead

PMO - Project Management Organization

PMP - Project Management Plan

PMT - Project Management Team

ODOT - Oregon Department of Transportation

OR - State of Oregon

OS - Operating System

SDL - System Development Lead

SEMP - Systems Engineering Management Plan

SyRS - System Requirements Specification Document

TBD - To Be Determined

TNC - Transportation Network Company

WA - State of Washington

WBS - Work Breakdown Structure

WSDOT - Washington State Department of Transportation

WSTA - Washington State Transportation Association

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