TransitMate

Final Report

CS 194H | Spring 2022

Amber P., Shina P., Katie P., Pramod K.

TABLE OF CONTENTS

PROBLEM DESCRIPTION

From our need-finding phase of CS 147, we found that interviewees who used public transportation often felt scared while traveling alone, especially at night and in unfamiliar places. Existing solutions like Noonlight, Life 360, and Find My Friends have varying success with considerations like safety and location sharing, however they all fail at upholding user privacy. People need a solution that maintains their privacy while sharing location-based safety information with their network.

SOLUTION OVERVIEW

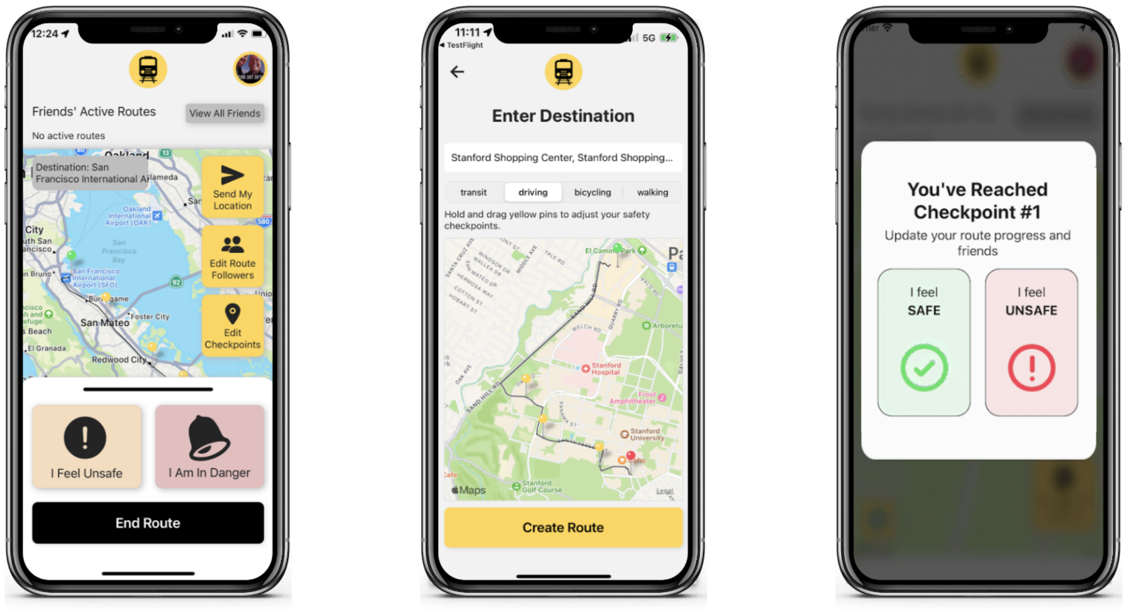
TransitMate hopes to allay the fears of taking public transportation alone by making it easier for people to let friends know where they are throughout their trip and immediately connect to trusted friends when they feel unsafe. Users can easily update friends on their location, safety, and travel progress when they want to, all while maintaining their privacy.

Value Proposition

Public Transportation Made Safer.

Mission Statement

Ensure that someone using public transportation feels safe and “unalone” throughout their trip.



Hold and drag yellow pins to adjust your safety checkpoints.

Update your route progress and friends

Key TransitMate screens, from left to right:
while on a route, creating a route, and reaching a checkpoint.

TASKS

To best promote safety on public transportation, we created and implemented the following four tasks of varying complexity.

Task #1 - Ping location (simple task)

You're traveling alone and want to send your current location to your friends to let them know where you are. We selected this task because at the core of our goal of promoting safety, sharing information about your current location is critical.

Task #2 - Request a friend's current location (moderate task)

Your friend is traveling, and you want to know where they are/if they are okay. You can ping for their current location and follow up if they don't respond. This task directly branches from our goal of promoting safety through the creation of an information loop between a user and their friends. A user can request information about their friend’s location at any time to stay informed about their safety.

Task #3 - Send intended travel route (moderate task)

You’re traveling alone, and you want to notify your friends of the route that you’re taking. This task is essential to amplifying the priority of sharing location information and safety by incorporating visibility of a user’s expected location in the near future.

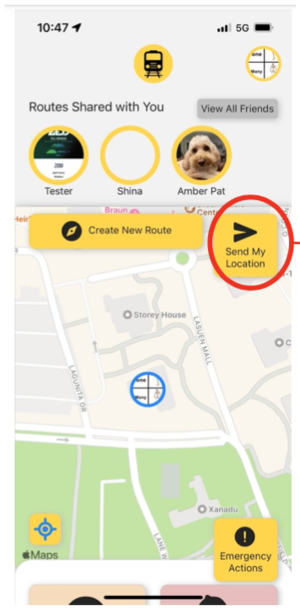
Task #4 - Send checkpoint updates (complex task)

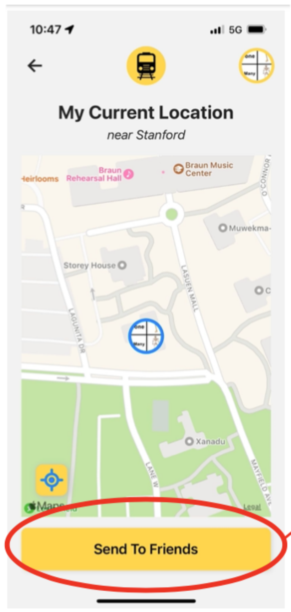
You’re traveling alone and want to notify someone that you’ve reached certain checkpoints safely along your route in real-time. This task is a major contribution to ensuring safety. Not only can the friends of a user view an intended route, but they can also now be aware of when a user reaches locations along that route. Additionally, when combined with route visibility, friends are able to be more informed about the user’s safety status.

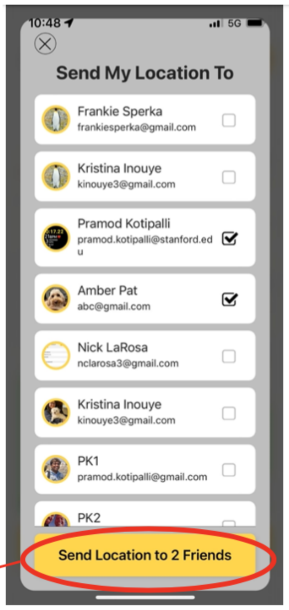
Next, we will present our task flows.

TASK FLOWS

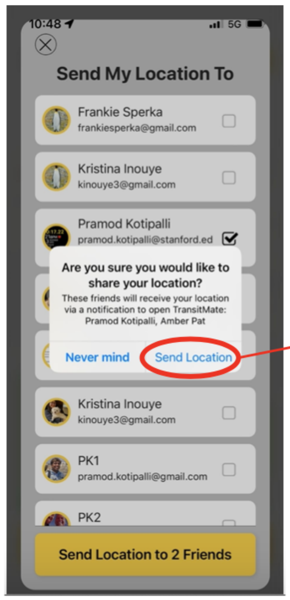
Task 1 - Send Your Location







Frankie Sperka frankiesperka@gmail.com ☐
Kristina Inouye kinouye3@gmail.com ☐
Pramod Kotipalli pramod.kotipalli@stanford.edu ✓
Amber Pat abc@gmail.com ✓
Nick LaRosa nclarosa3@gmail.com ☐
Kristina Inouye kinouye3@gmail.com ☐
PK1 pramod.kotipalli@gmail.com ☐
PK2

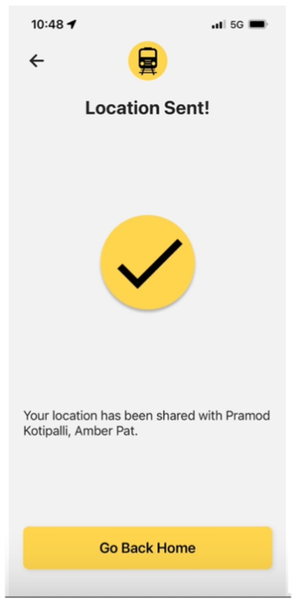


Frankie Sperka frankiesperka@gmail.com ☐
Kristina Inouye kinouye3@gmail.com ☐
Pramod Kotipalli pramod.kotipalli@stanford.ed ✓

Are you sure you would like to share your location?

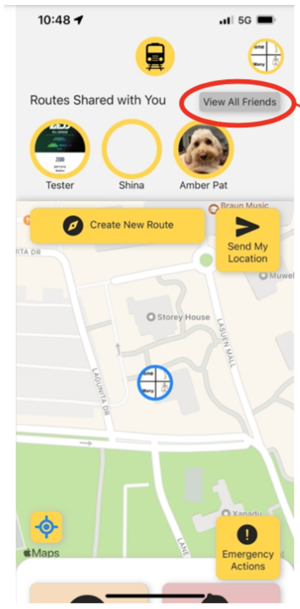
These friends will receive your location via a notification to open TransitMate: Pramod Kotipalli, Amber Pat

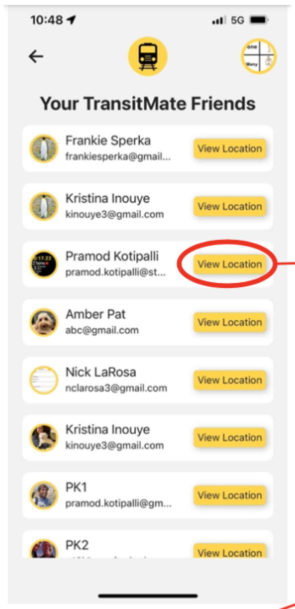
Kristina Inouye kinouye3@gmail.com ☐
PK1 pramod.kotipalli@gmail.com ☐
PK2



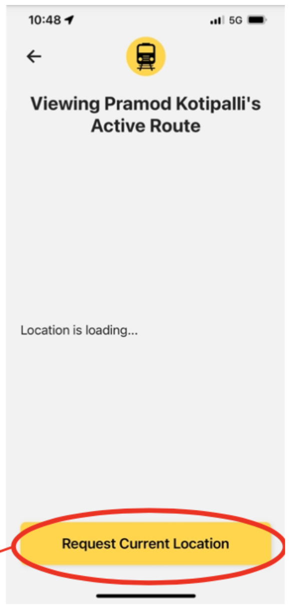
Your location has been shared with Pramod Kotipalli, Amber Pat.

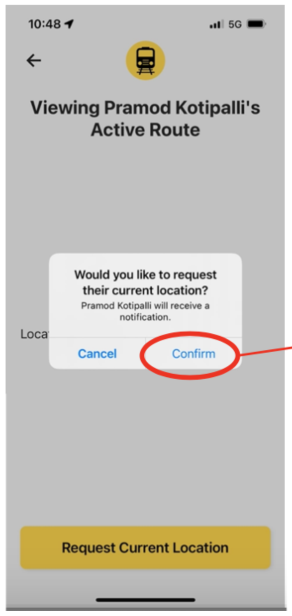
Task 2 - Request A Location



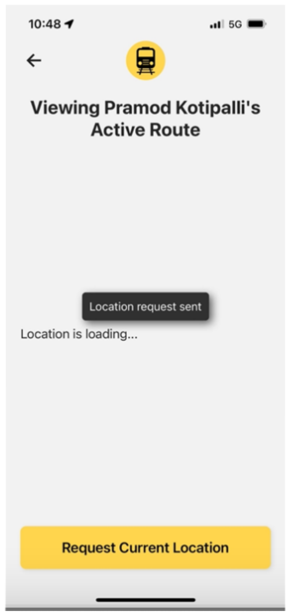


Frankie Sperka frankiesperka@gmail... View Location
Kristina Inouye kinouye3@gmail.com View Location
Pramod Kotipalli pramod.kotipalli@st... View Location
Amber Pat abc@gmail.com View Location
Nick LaRosa nclarosa3@gmail.com View Location
Kristina Inouye kinouye3@gmail.com View Location
PK1 pramod.kotipalli@gm... View Location
PK2 View Location

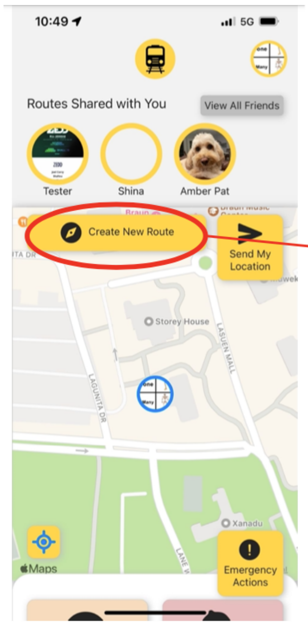


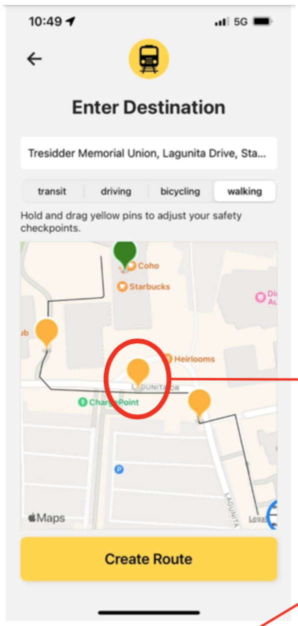


Would you like to request their current location?
Pramod Kotipalli will receive a notification.



Task 3 - Create and Share a Route

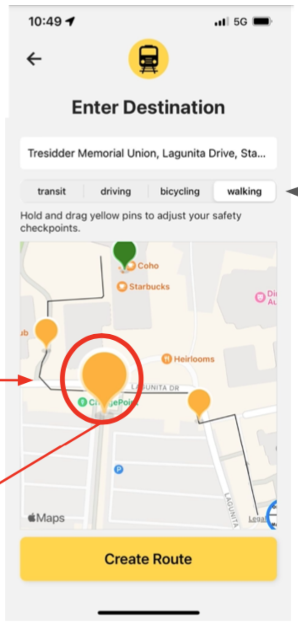




Tresidder Memorial Union, Lagunita Drive, Sta...

Hold and drag yellow pins to adjust your safety checkpoints.

Drag and drop checkpoint

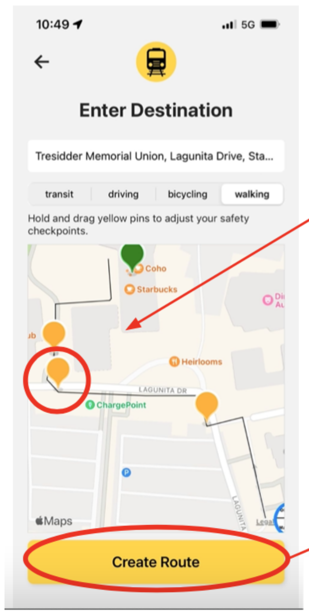


Tresidder Memorial Union, Lagunita Drive, Sta...

Hold and drag yellow pins to adjust your safety checkpoints.

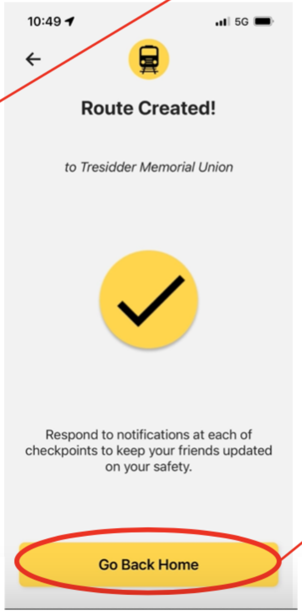
Choose travel mode

Choose destination



Tresidder Memorial Union, Lagunita Drive, Sta...

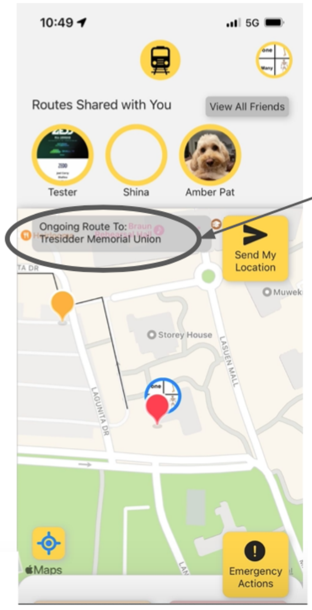
Hold and drag yellow pins to adjust your safety checkpoints.



Route Created!

to Tresidder Memorial Union

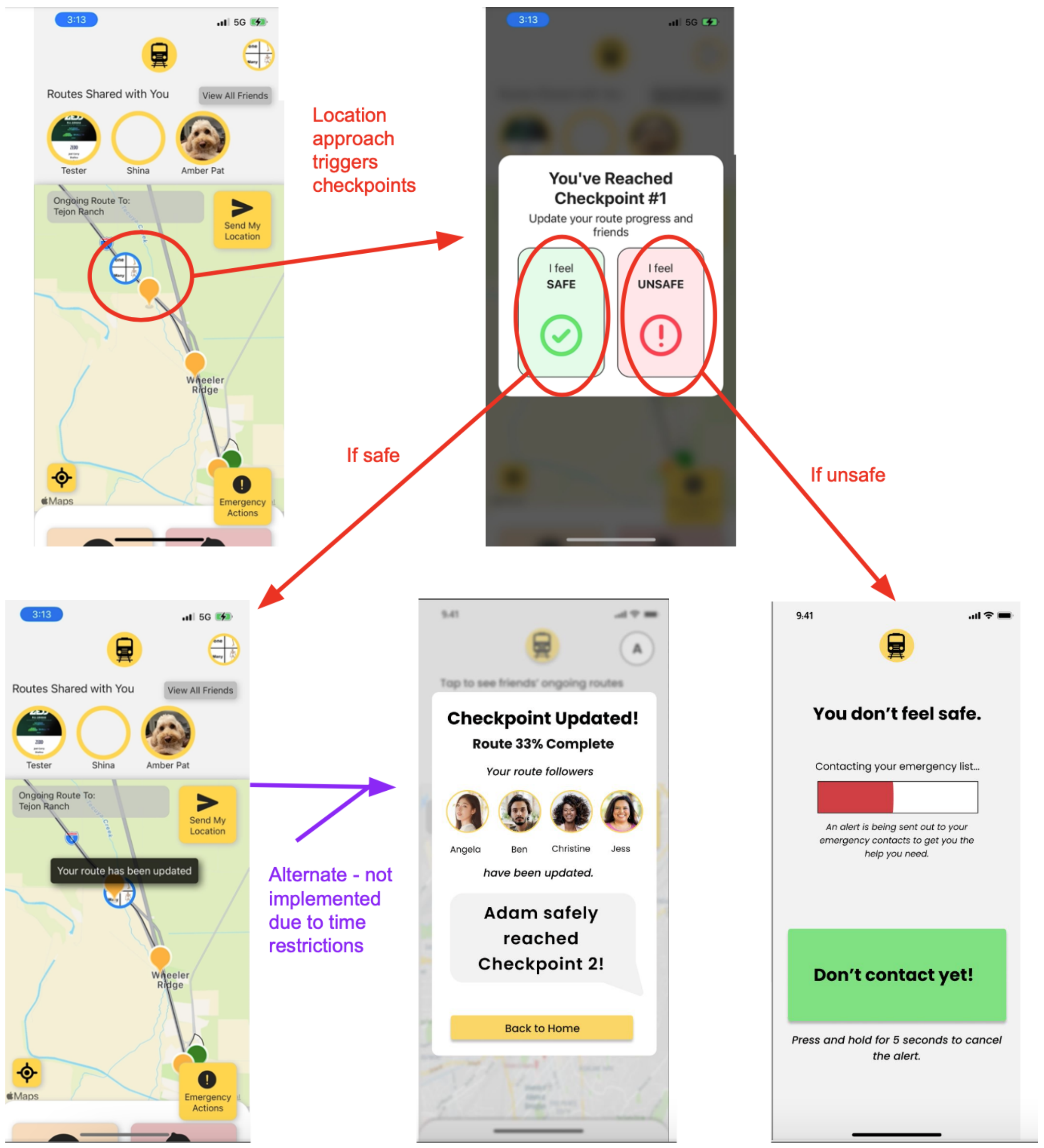
Respond to notifications at each of checkpoints to keep your friends updated on your safety.



Ongoing Route To: Tresidder Memorial Union

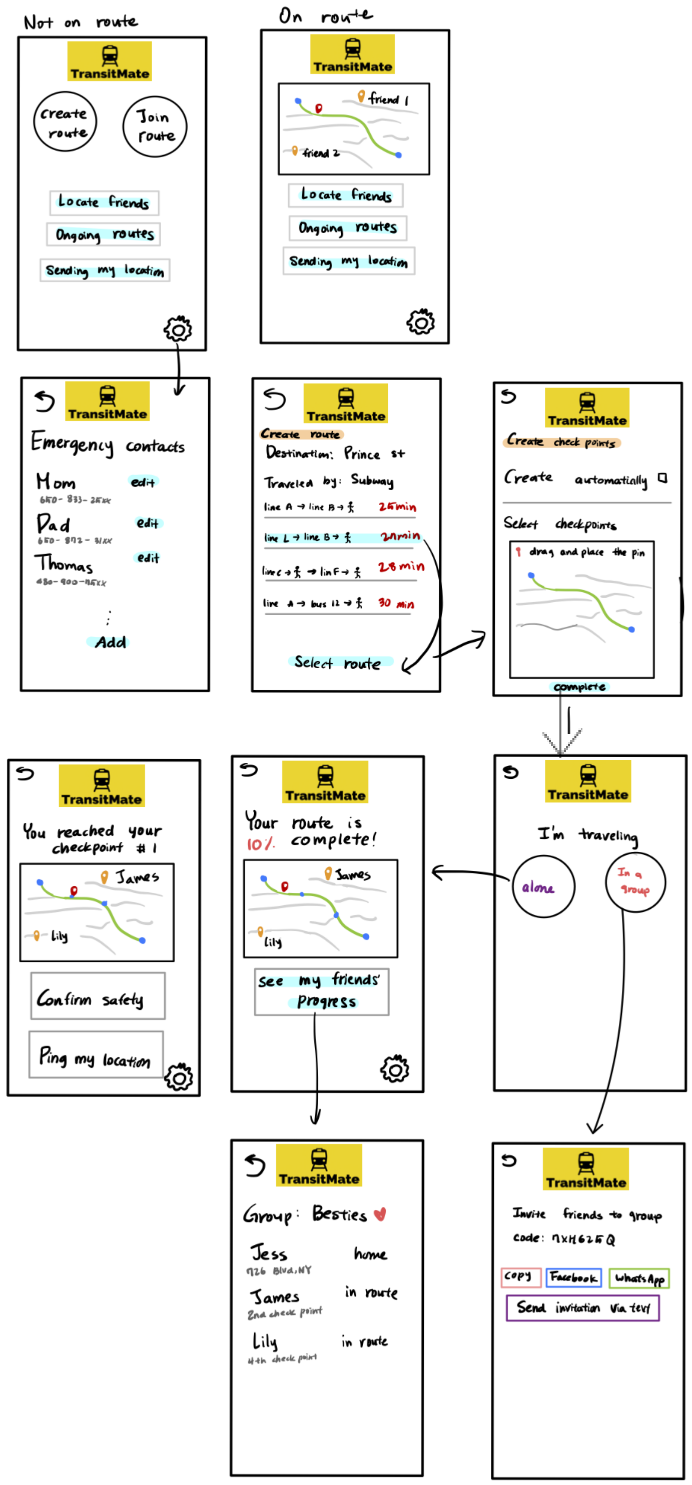
Now on route

Task 4 – Update Route at Checkpoints

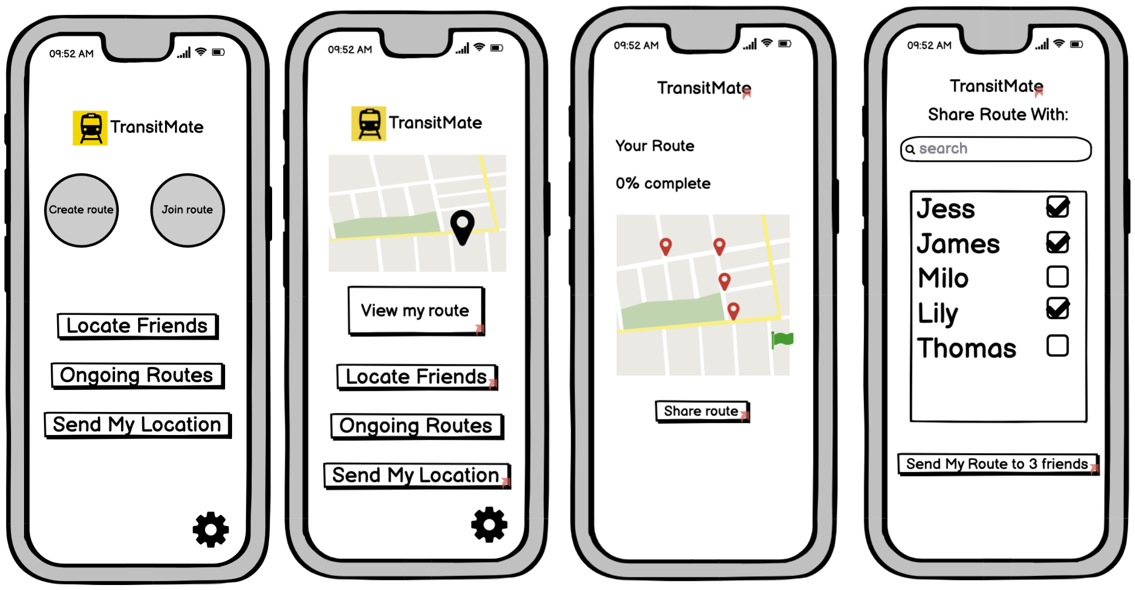

3:13
Routes Shared with You
View All Friends
Tester
Shina
Amber Pat
Ongoing Route To: Tejon Ranch
Send My Location
Wheeler Ridge
Emergency Actions
Maps
Location approach triggers checkpoints
You've Reached Checkpoint #1
Update your route progress and friends
I feel SAFE
I feel UNSAFE
If safe
If unsafe
Your route has been updated
Alternate - not implemented due to time restrictions
9:41
Tap to see friends' ongoing routes
Checkpoint Updated!
Route 33% Complete
Your route followers
Angela
Ben
Christine
Jess
have been updated.
Adam safely reached Checkpoint 2!
Back to Home
You don't feel safe.
Contacting your emergency list...
An alert is being sent out to your emergency contacts to get you the help you need.
Don't contact yet!
Press and hold for 5 seconds to cancel the alert.

DESIGN EVOLUTION

Below is our initial sketch for TransitMate's tap-based mobile UI.



This sketch was the basis for our low-fidelity prototype, which we created in Balsamiq. Some screens from the low-fidelity prototype are shown below:



Low-fi prototype testing

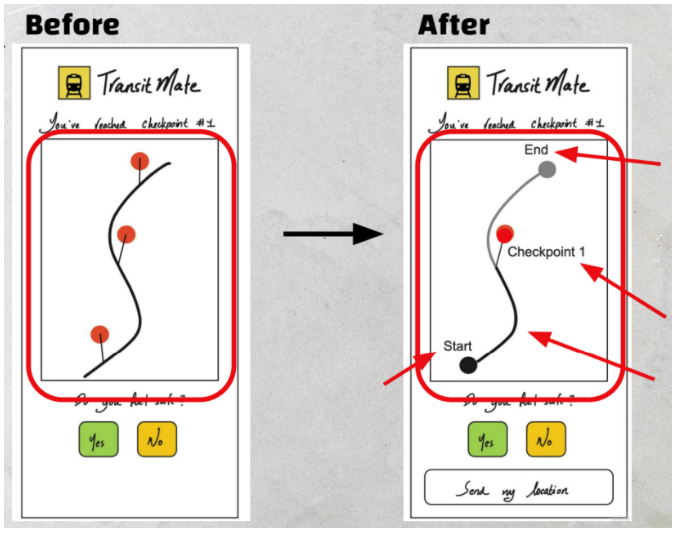
We evaluated this prototype by recruiting four people who regularly used public transportation to participate in remote testing over Zoom. The buttons on each screen of the prototype are wired to the corresponding screens, so Balsamiq could play “computer” for us during the testing phase. Therefore, we only needed one team member to act as a greeter who introduced the test and tasks while the other team members could observe and take notes. The participants were encouraged to voice their thoughts, impressions, and reasoning as they interacted with the prototype and completed each task supported by it.

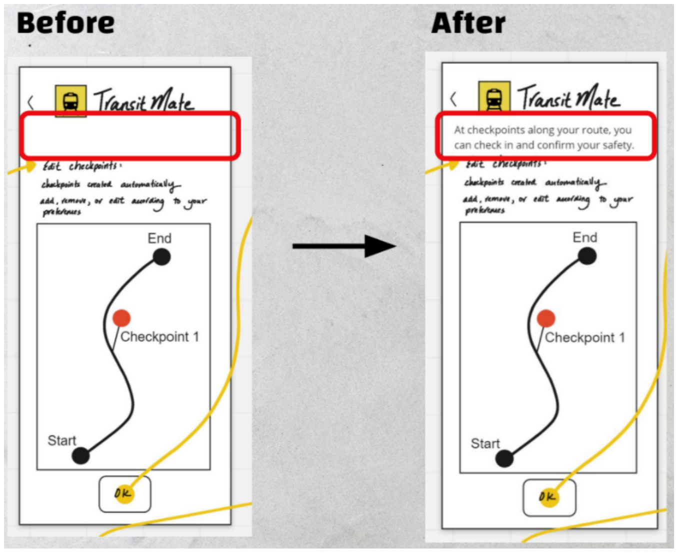
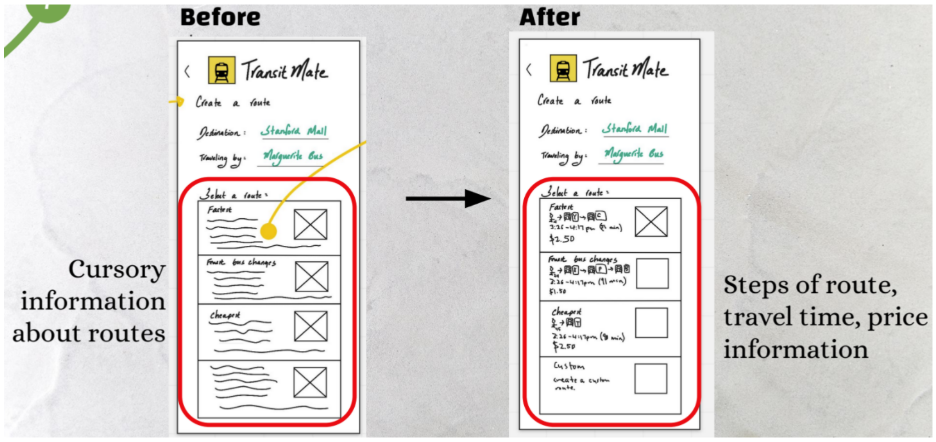
All of the tasks were completed without major usability issues; that is, the participants all successfully completed them with minimal confusion and no guidance. In particular, they liked that the prototype had no screen scrolling, a clear layout, and the ability to plan routes and coordinate groups all within the app.

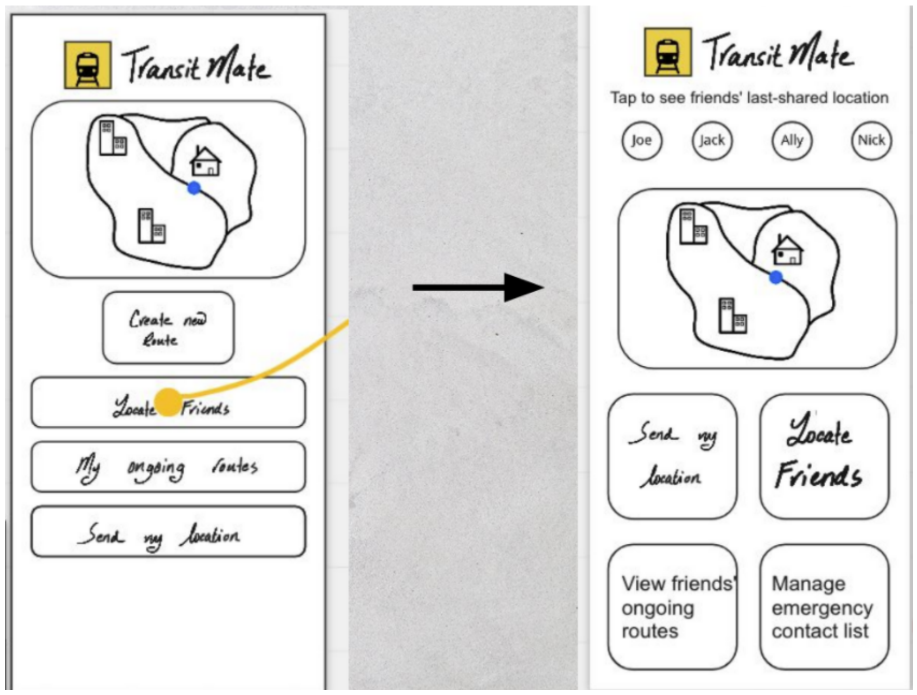
However, participants tended to ask for failsafes and more clarity. They wanted to be able to reverse decisions, find out what would happen if they selected a certain option, see more information about the maps and checkpoints, and receive explicit confirmation after completing an action. We implemented these in a medium-fidelity prototype, which includes back buttons, labels on maps, more explanations for buttons and concepts that were previously unclear, and confirmation screens, among other UI changes.

Design changes for med-fi prototype

The four major design changes we implemented in our medium-fidelity prototype are as follows:

1. *Checkpoints and the start and end points of a route are clearly labeled. Checkpoints are also colored in a way that differentiates the traveled and untraveled portions of the route.*
    a. Rationale: Our testers had a lot of trouble interpreting maps, figuring out their travel direction, and determining which checkpoints were which, so we added clarifying features to minimize this confusion.
    b. 

2. *We added a short explanation at the top of the checkpoint screen to tell the user why they were being asked to create and edit checkpoints along their route.*
    a. Rationale: Our testers seemed unsure of why they were being shown checkpoints and asked what the checkpoints were used for. We wanted to provide more clarity at each step to ensure that the user knew what they were doing and we were asking them to do it.
    b. 
Before
After
Transit Mate
At checkpoints along your route, you can check in and confirm your safety.
Edit checkpoints:
checkpoints created automatically
add, remove, or edit according to your preferences
End
Checkpoint 1
Start
OK
3. A route has icons showing the user what bus/train changes the route consists of, the ETA with travel duration time, and the cost.
    a. Rationale: Our testers wanted more details about the suggested routes, such as what the step-by-step process was for each one, how long they took, and how much they cost. We decided to give them easy access to this information.
    b. 

4. The action buttons are in a grid format, making them bigger and easier to quickly tap. We also added the ability to see friends' last-shared locations from the home screen; this allows the user to quickly tap on a friend and see where they were last located.
    a. Rationale: Making the buttons larger and putting them in a grid format will allow travelers in a hurry to quickly access what they need. Also, having friends' last-shared locations on the home screen allows the user to avoid having to navigate through multiple screens to get this information.
    b. 

The last major change we made in our medium-fidelity prototype was the removal of the "group route" task in which a group of friends could share the same route and make sure that all group members got to their respective destinations safely. This was initially for ensuring that friends got home safely after separating, but we realized that the other tasks already addressed this issue, and this task was not central to our needfinding or the differentiation of our app from others according to our market research. It did not influence the main focus of our idea—to help someone feel safer while using public transportation alone. We felt that concentrating on helping someone travel alone would better meet these needs and unify our concept, so we decided to no longer support this task.

See the appendix for a screenshot of our medium-fidelity prototype framework on Figma.

Heuristic evaluation on med-fi Figma prototype

Our classmates tested our medium-fidelity prototype by conducting a heuristic evaluation based on Jakob Nielsen's 10 general principles for interaction design. They reported 22 violations of concerning severity (levels 3 and 4).

The following are nine reported violations for which we did not implement fixes because they were addressed as limitations in the README document accompanying the medium-fidelity prototype, solvable using the Google Maps API, or approved by our TA beforehand:

1. Users cannot cancel an emergency alert after the alert has been sent.
2. While on a route, the user does not see with whom the route is being shared.
3. A user cannot modify a route once it is in progress.
4. The colors green and red are used as contrasting colors signifying positivity and negativity, respectively.
5. Displayed route choices do not include information about whether they are accessible to people with disabilities.
6. The user must check in at checkpoints by entering the app.
7. The user cannot view a route option on a map before choosing it.
8. The options for methods of transportation are constraining.
9. Someone following a friend's route in the app cannot express concern if they become worried.

Below are the remaining violations we did correct, along with their fixes:

1. There was a mismatch in wording such that a button was labeled "Send Request" rather than "Share Route," which was closer to the button's function.
    a. Fix: We changed the wording to "Share Route."

2. Users could not easily cancel an ongoing route at any time.
    a. Fix: We added an “End Route” button on every checkpoint screen.
3. The home button is not clearly marked.
    a. Fix: We added a “Cancel” button on many screens to give users an intuitive way to return to the home screen.
4. One of the back buttons was not properly wired and took the user back through the process of importing a phone contact into the app.
    a. Fix: We rewired the back button to return to the previous main screen.
5. While on a route, the home screen displayed a map of the current route, but it did not show checkpoints or the percentage of the route traveled.
    a. Fix: We added the checkpoints and the percentage of the route traveled to the displayed route on the home screen.
6. There was confusion about how sending a location worked and how it differed from sending routes.
    a. Fix: We revised our onboarding screen to clarify that location sharing was not continuous and our route-displaying screen to clarify that the user could choose to stop sharing a route with someone.
7. There seemed to be little distinction between locating friends and viewing friends’ ongoing routes.
    a. Fix: We combined the two options into one feature and renamed “Locate Friends” accordingly.
8. The color red was usually used in our app to indicate negativity, but the button for someone to choose not to contact their emergency list, which should have been associated with positivity, was red.
    a. Fix: We changed the button color to green and instead made the progress bar for contacting the emergency list red.
9. There was no confirmation before sending a request for one or more people’s locations, which could lead to errors.
    a. Fix: We added a prompt for the user to confirm the location request before the request was sent.
10. There was no confirmation before setting checkpoints, which could not be edited afterward.
    a. Fix: We added a prompt for the user to confirm their checkpoints before proceeding.

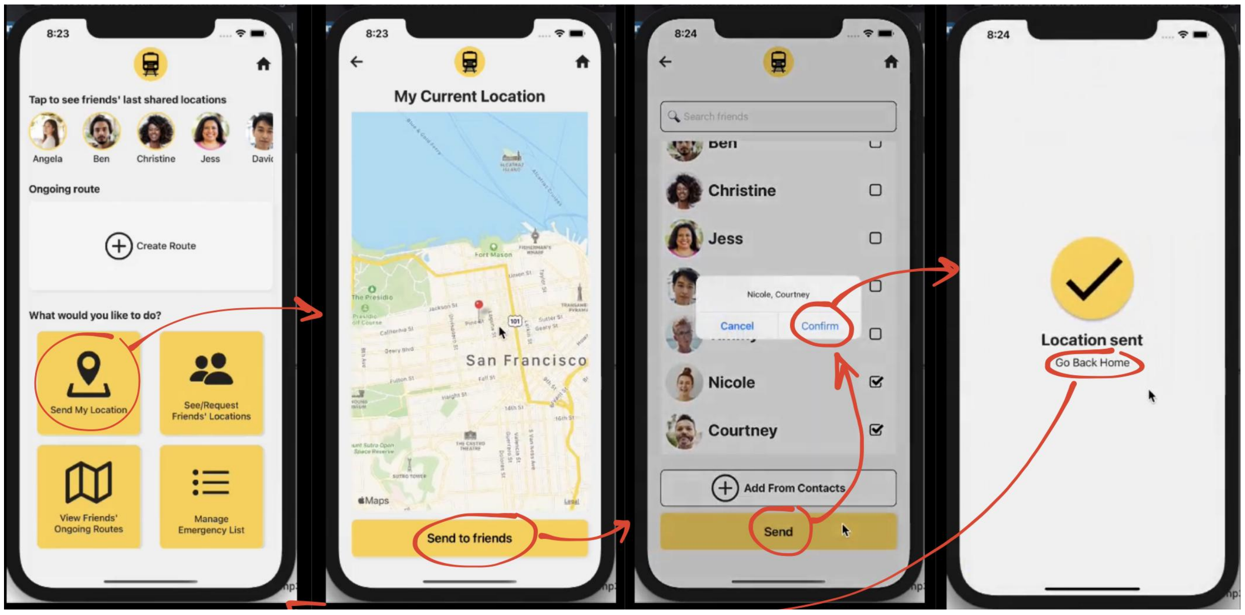
11. It was unclear what an emergency list was used for.
    a. Fix: We added information about what the emergency list was and how it would be used on the emergency list screen.
12. There was no help documentation or FAQ in the app.
    a. Fix: We added a settings icon to the home screen that would hold such information.
13. There was no way for a user to save a frequently-used route for expedited future use.
    a. Fix: We added a way to save routes and select a saved route when creating a route.

Hi-fi prototype, v1

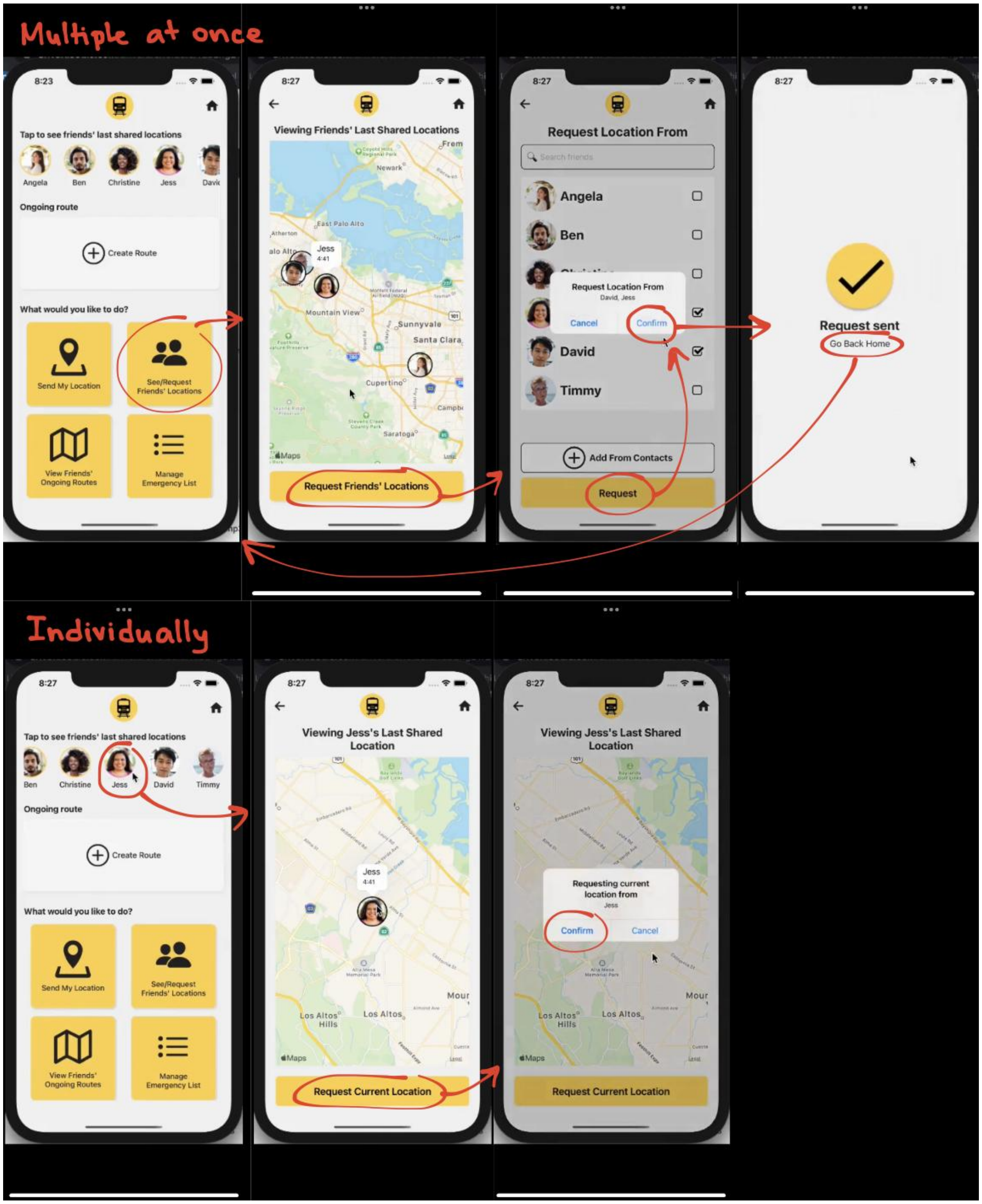
Our high-fidelity V1 prototype incorporated these fixes to the extent that was feasible in React Native in the last few weeks of CS 147.

Below is a walkthrough of each task in our high-fidelity V1 prototype:

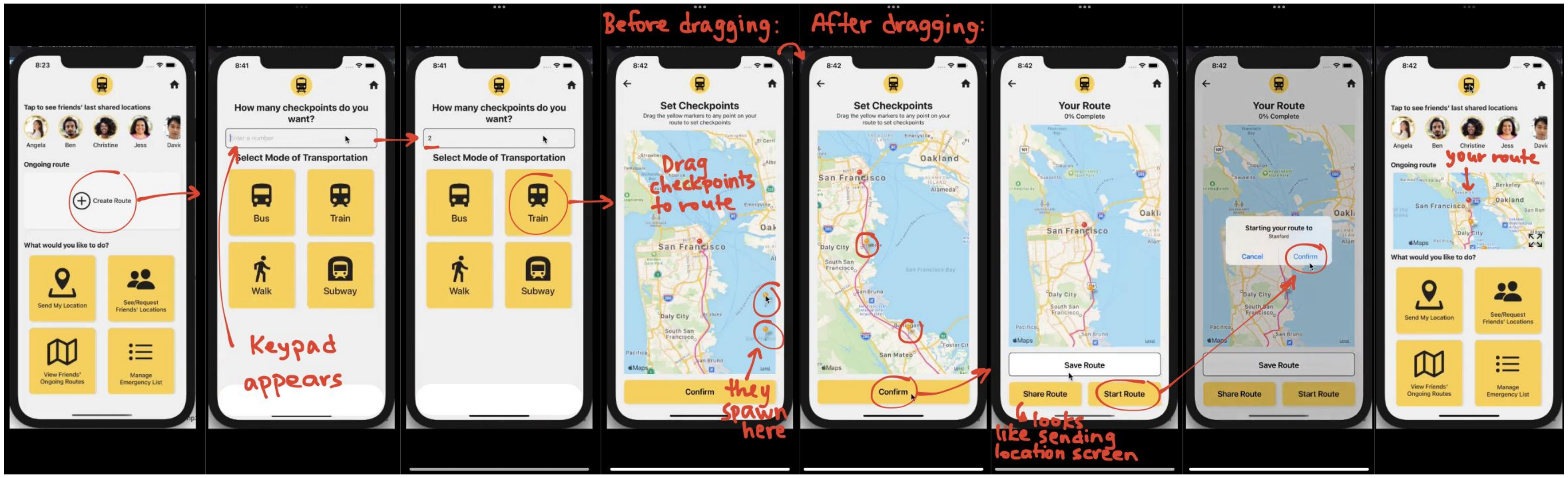
<u>Task #1 - Send Your Location</u>



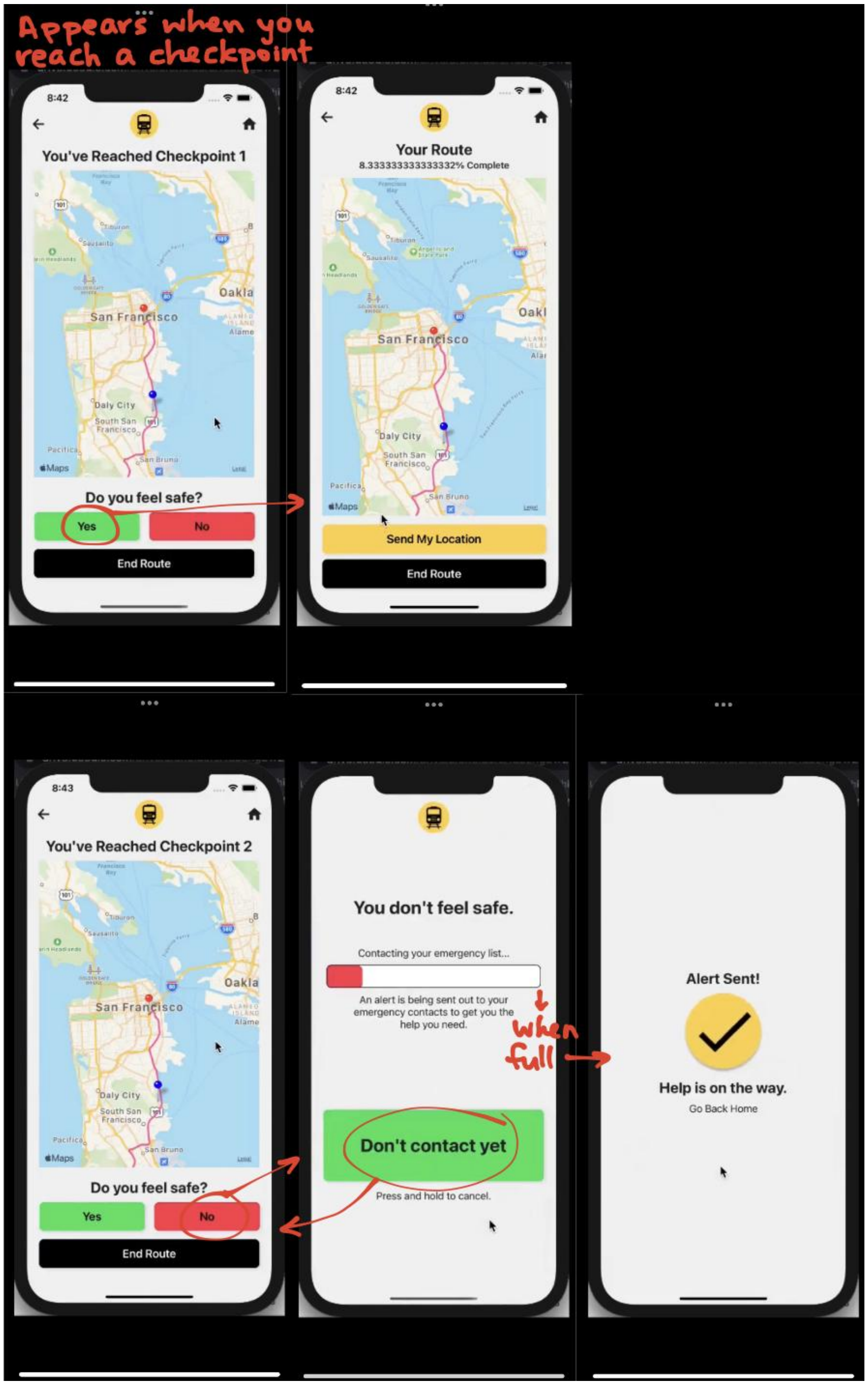
<u>Task #2 - Request a Friend's Location</u>


Multiple at once
Tap to see friends' last shared locations
Angela
Ben
Christine
Jess
David
Ongoing route
Create Route
What would you like to do?
Send My Location
See/Request Friends' Locations
View Friends' Ongoing Routes
Manage Emergency List
Viewing Friends' Last Shared Locations
Request Friends' Locations
Request Location From
Search friends
Timmy
Request Location From David, Jess
Cancel
Confirm
Add From Contacts
Request
Request sent
Go Back Home
Individually
Viewing Jess's Last Shared Location
Request Current Location
Requesting current location from Jess
Confirm
Cancel

Task #2 - Create a Route


Before dragging:
After dragging:
Tap to see friends' last shared locations
Ongoing route
Create Route
What would you like to do?
Send My Location
See/Request Friends' Locations
View Friends' Ongoing Routes
Manage Emergency List
How many checkpoints do you want?
Select Mode of Transportation
Bus
Train
Walk
Subway
Keypad appears
Set Checkpoints
Drag the yellow markers to any point on your route to set checkpoints
Drag checkpoints to route
they spawn here
Confirm
Your Route
0% Complete
Save Route
Share Route
Start Route
looks like sending location screen
Starting your route to Stanford
Cancel
Confirm
your route

Task #3 - Confirm Your Safety at Route Checkpoints

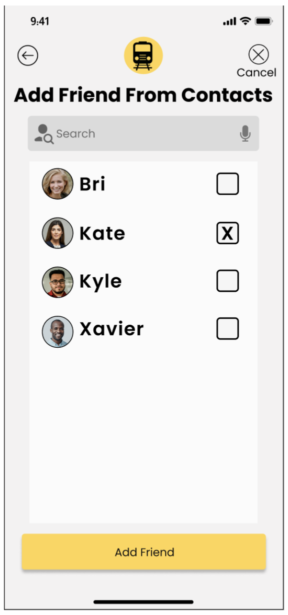

Appears when you reach a checkpoint
8:42
You've Reached Checkpoint 1
Do you feel safe?
Yes
No
End Route
8:42
Your Route
8.333333333333332% Complete
Send My Location
End Route
8:43
You've Reached Checkpoint 2
Do you feel safe?
Yes
No
End Route
You don't feel safe.
Contacting your emergency list...
An alert is being sent out to your emergency contacts to get you the help you need.
Don't contact yet
Press and hold to cancel.
when full
Alert Sent!
Help is on the way.
Go Back Home

The creation of our high-fidelity V1 prototype ended our time in CS147.

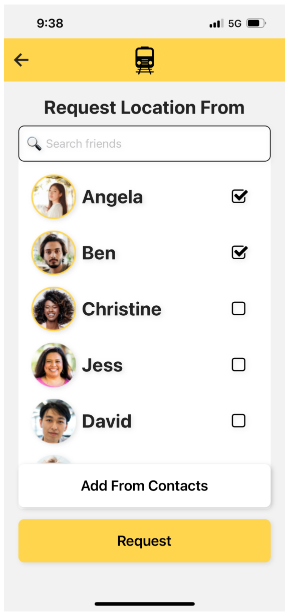
Improved hi-fi v2 for CS 194H

Entering CS194H, we reimplemented some of the screens and improved the functionality of the prototype so that it supported directions from Google Maps and became able to simulate moving along a route. We also made minor design changes such as those below.

Original



Redesign



With this improved version of our high-fidelity prototype V1, we conducted a lab usability study with four participants who had experience using public transportation in various cities across the United States. The study was conducted over Zoom, and participants were each compensated with $15 Amazon gift cards for their time. We asked each participant to find a quiet room for the duration of the test so as to avoid distractions and gauge their full reactions to the app. When the participant was ready, we guided them through downloading Expo Go and sent them a link to download the app on their device. Participants were encouraged to voice their thoughts, impressions, and reasoning as they interacted with the prototype and completed each task supported by it.

Following completion of each task, we asked participants to complete a form with the NASA TLX (task load index, a scaled questionnaire meant to assess how taxing a task is to perform). This helped us with our test measures; in particular, we documented the number of taps it took to complete each task, the amount of time it took to complete each task, and how taxing a participant felt each task was to complete. In this study, we did not count the number of errors participants made because the numbers have always been extremely low for our app, and we could gauge the number of errors through the numbers we were collecting (mainly the number of taps).

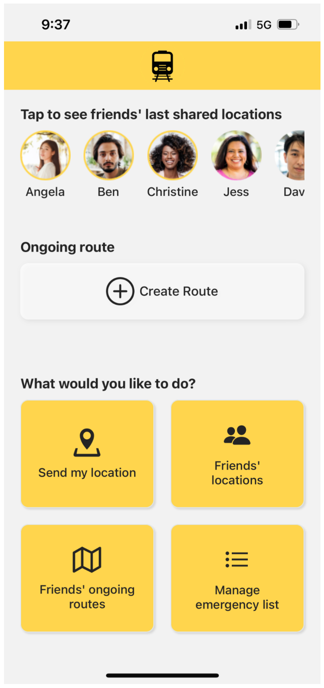
The following are the key difficulties participants had while using the app:

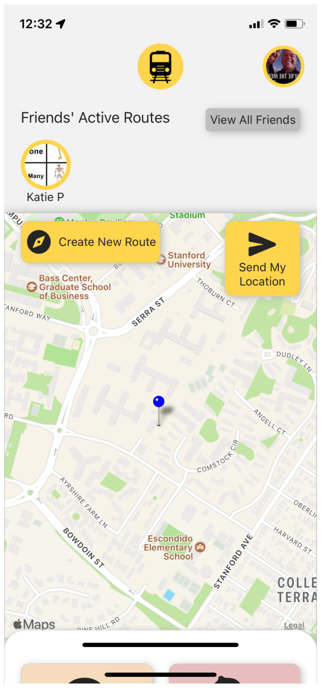
- Participants were confused by what pins on the map were and how to move checkpoints. They wanted the meanings of pin colors to be clearer and a way of learning that checkpoints could be dragged.
- Participants found the positioning of the Saved Routes button unintuitive.
- Participants did not know or guess that the icon at the top of the screen was a home button.
- Participants wanted to know what exactly was being sent to others when the app notified them that a message had been sent.

Keeping these difficulties in mind, we began work on our high-fidelity V2 prototype. We made four main changes to it. Each original design is followed by the redesign below, along with the rationale for each change.

1. Home Screen

a.





b. Rationale

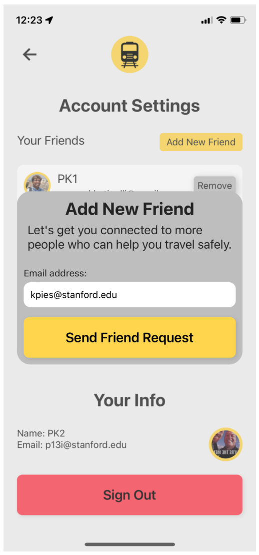
   i. The top bar being a uniform yellow does not afford that the logo in the center is a home button.

   ii. Friends' most recently shared locations are not frequently used on their own, so there is little justification for them to be on the home screen.

   iii. The yellow boxed buttons take up too much space without having a justifiable amount of usability or importance.

   iv. A transportation app should be centered around maps and location.

2. Accounts



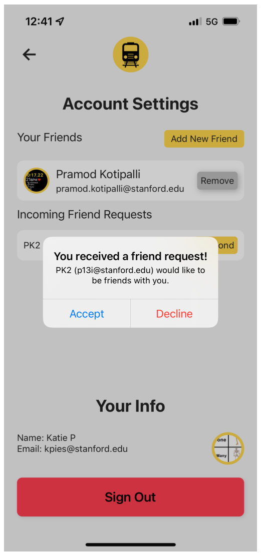
Add New Friend

Let's get you connected to more people who can help you travel safely.

Email address: kpies@stanford.edu

Your Info

Name: PK2
Email: p13i@stanford.edu



Pramod Kotipalli
pramod.kotipalli@stanford.edu

You received a friend request!

PK2 (p13i@stanford.edu) would like to be friends with you.

Your Info

Name: Katie P
Email: kpies@stanford.edu

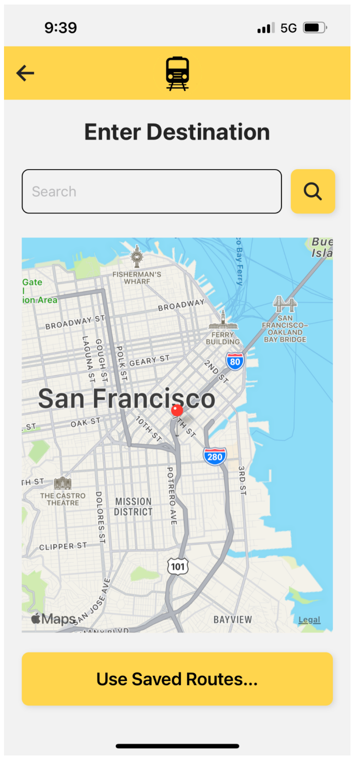
a. [No original screen]

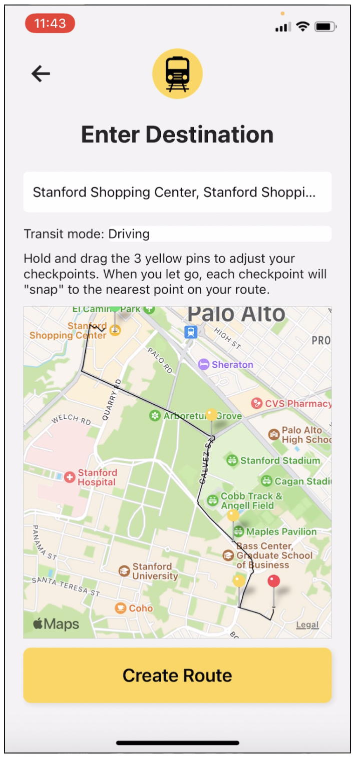
b. Rationale

   i. The implementation of accounts requires a way to view and manage accounts.

   ii. To accommodate the home screen changes, we moved the friend list to the Account Settings page. This way, only key information is on the home screen.

3. Routes





Transit mode: Driving

Hold and drag the 3 yellow pins to adjust your checkpoints. When you let go, each checkpoint will "snap" to the nearest point on your route.

a.

b. Rationale

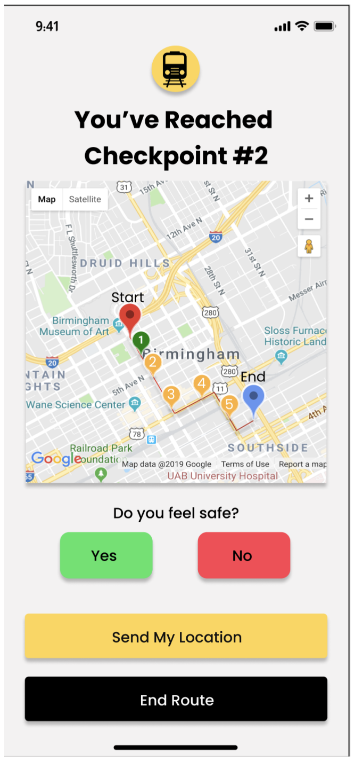
i. Checkpoints need to be automatically placed along the route and auto-snap to the route when dragged. This way, people will not have trouble generating checkpoints or accidentally place a checkpoint far from the route.

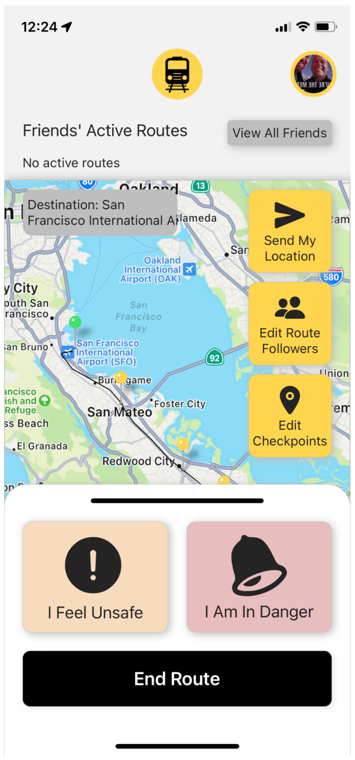
ii. We originally did not have live location or real route finding with different modes of transportation. These were vital to implement for our app's functionality.

iii. We decided to remove Saved Routes because it was confusing to our previous usability study participants and not yet necessary for testing.

4. Bottom Sheet

a.





b. Rationale

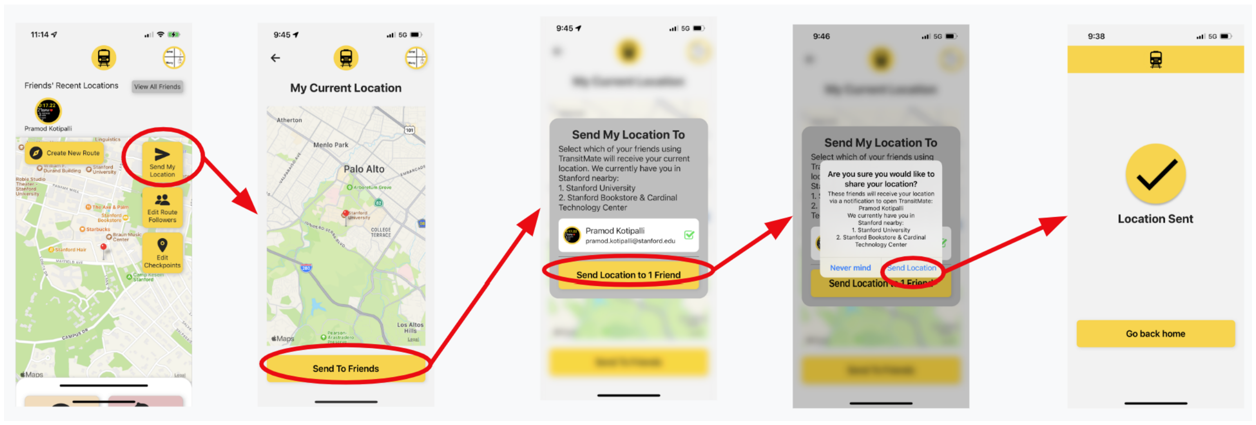
i. The button to end a route was accessible through the checkpoint confirmation and route information screen, but it should be easy to access at any time while on a route.

ii. We were missing a way to indicate danger at any time (and not only when updating a checkpoint). This was a component of our value proposition of safety.

Below is a walkthrough of each task in our high-fidelity V2 prototype.

Hi-fi v2 after lab usability study

Task #1 - Send Your Location

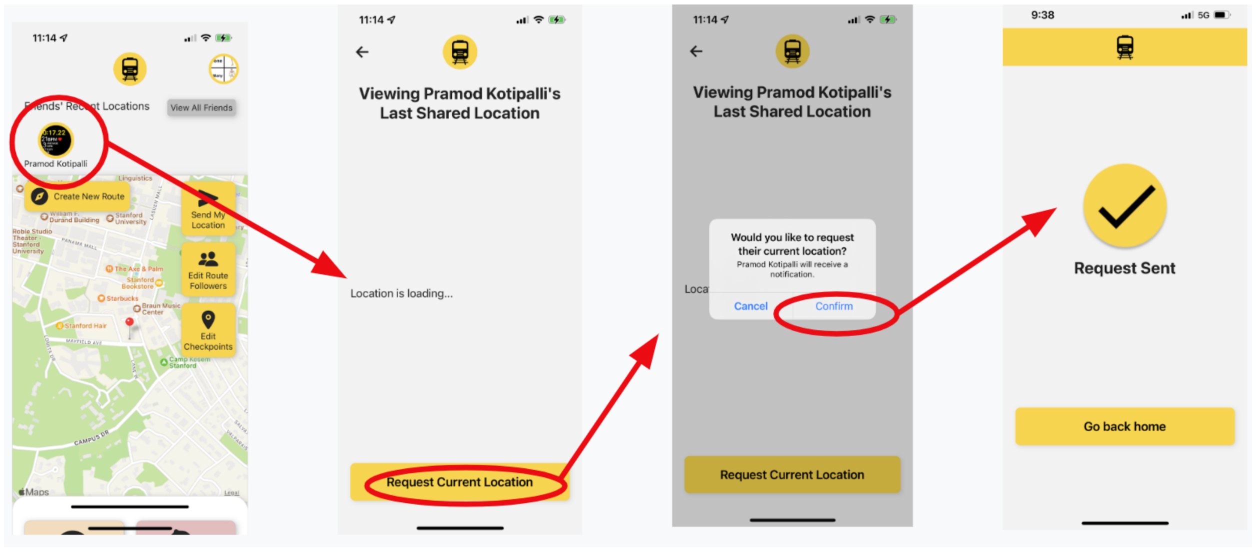


Select which of your friends using TransitMate will receive your current location. We currently have you in Stanford nearby:
1. Stanford University
2. Stanford Bookstore & Cardinal Technology Center

Pramod Kotipalli
pramod.kotipalli@stanford.edu

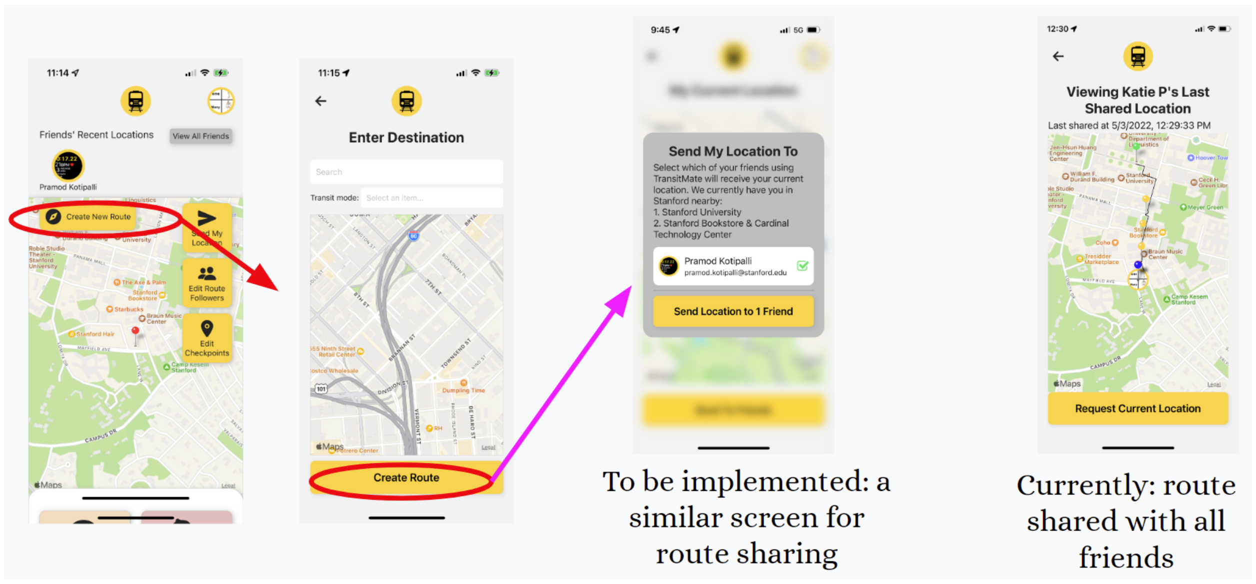
Are you sure you would like to share your location?
These friends will receive your location via a notification to open TransitMate:
Pramod Kotipalli
We currently have you in Stanford nearby:
1. Stanford University
2. Stanford Bookstore & Cardinal Technology Center

Task #2 - Request a Friend's Location

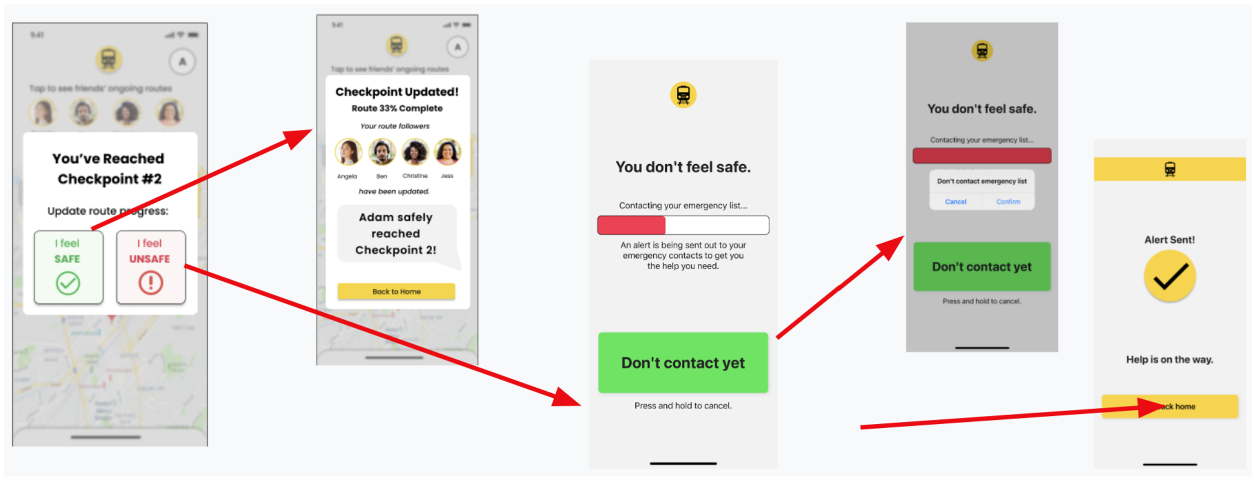


Would you like to request their current location?
Pramod Kotipalli will receive a notification.

Task #3 - Create a Route


Friends' Recent Locations
View All Friends
Pramod Kotipalli
Create New Route
Send My Location
Edit Route Followers
Edit Checkpoints
Enter Destination
Search
Transit mode:
Create Route
Send My Location To
Select which of your friends using TransitMate will receive your current location. We currently have you in Stanford nearby:
1. Stanford University
2. Stanford Bookstore & Cardinal Technology Center
Pramod Kotipalli
pramod.kotipalli@stanford.edu
Send Location to 1 Friend
To be implemented: a similar screen for route sharing
Viewing Katie P's Last Shared Location
Last shared at 5/3/2022, 12:29:33 PM
Request Current Location
Currently: route shared with all friends

Task #4 - Confirm Your Safety at Route Checkpoints


Tap to see friends' ongoing routes
You've Reached Checkpoint #2
Update route progress:
I feel SAFE
I feel UNSAFE
Checkpoint Updated!
Route 33% Complete
Your route followers
Angela
Ben
Christine
Jess
have been updated.
Adam safely reached Checkpoint 2!
Back to Home
You don't feel safe.
Contacting your emergency list...
An alert is being sent out to your emergency contacts to get you the help you need.
Don't contact yet
Press and hold to cancel.
Don't contact emergency list
Cancel
Confirm
Alert Sent!
Help is on the way.
Back home

With our high-fidelity prototype V2, we conducted a field study with five participants, two of whom were acquaintances and three random people we found at the Stanford Shopping Center. They were compensated with $15 Amazon gift cards for their time.

All previous testing of our concept and app had been done indoors, so the purpose of this study was to test how well TransitMate promoted safety in typical transportation scenarios. We first introduced ourselves, CS194H, and TransitMate to participants, and we asked them if they would be willing to help us test our prototype. We then gave them the consent forms and explained to them what they would be doing. We asked them to talk aloud so that we would know their thoughts, impressions, and reasoning as they interacted with the prototype and completed each task.

During the setup, we asked participants to download Expo Go, and once they had our app running on their devices, we gave them a basic tutorial of how to navigate the app. We then asked them to complete tasks one by one, recording the time and number of clicks used for each task using Firebase. After each task, we asked them a few followup questions and had them fill out the NASA TLX form on Google Forms. At the end of the test, we received their overall thoughts, answered any questions they had for us, and thanked them for participating.

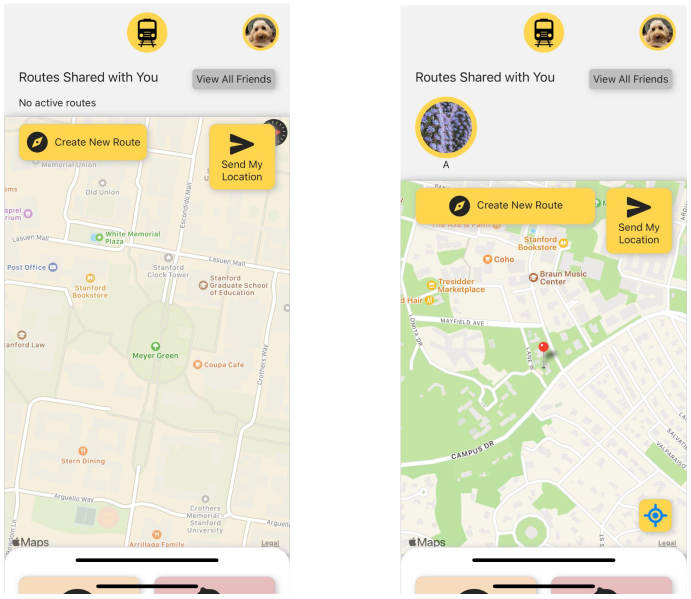
Below are our key findings, along with what we learned from them:

- Successes
    - All participants successfully completed the tasks they had been given with minimal error.
    - Even subjective feelings of failure reported on the NASA TLX remained relatively low.
    - Learned: Using the app while in transit did not pose significant problems for participants. The concept seems feasible in practice.
- Failures
    - Onboarding may not have been familiarizing new users to the system enough, creating more effort for the first task participants completed. All participants were asked to send their location first, and we saw a surprisingly high number of taps, amount of time taken, and reported effort for this simple task.
    - Task 3, creating a route, could be further simplified to lower the number of taps, completion time, and reported effort.

- Multiple participants became confused by the colors of the pins on maps.
- Learned: There were no critical errors, but the confusing screens, buttons, and icons should be changed.

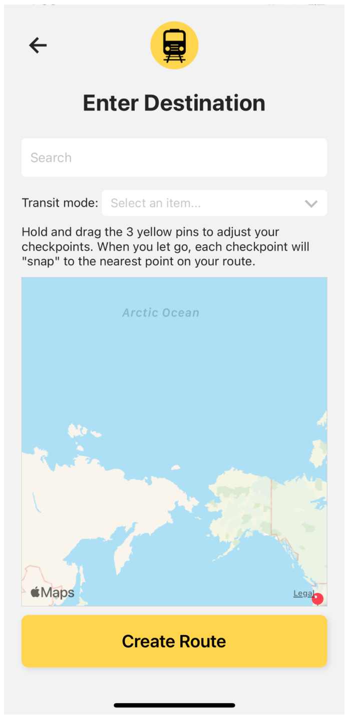
With our notes on how to improve the app, we moved on to creating our high-fidelity prototype V3. We made three main changes to it. Each design is followed by the redesign below, along with the rationale for each change.

1. Home Screen Map Follow Button

   a. 

   b. Rationale: While the user is moving, the map does not automatically shift to center the user's current location. This might lead to the user's location pin leaving the screen. The addition of the follow button in the bottom right corner turns on centering of the user's location so that the map follows the user.

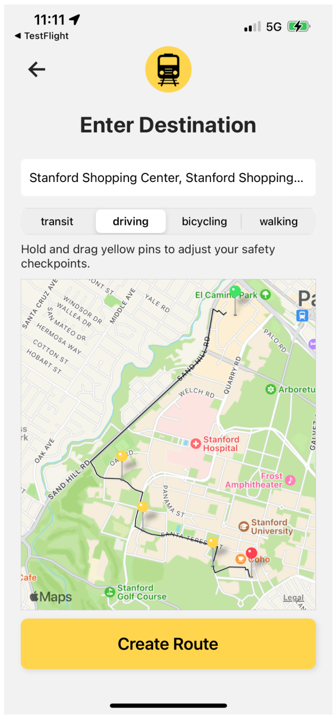
2. Mode of Transportation

a. 
Enter Destination

Search

Transit mode: Select an item...

Hold and drag the 3 yellow pins to adjust your checkpoints. When you let go, each checkpoint will "snap" to the nearest point on your route.



Enter Destination

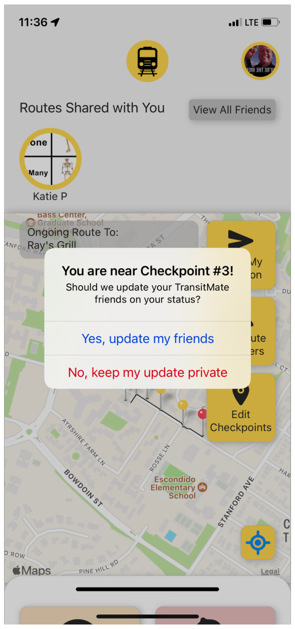
Stanford Shopping Center, Stanford Shopping...

transit | driving | bicycling | walking

Hold and drag yellow pins to adjust your safety checkpoints.

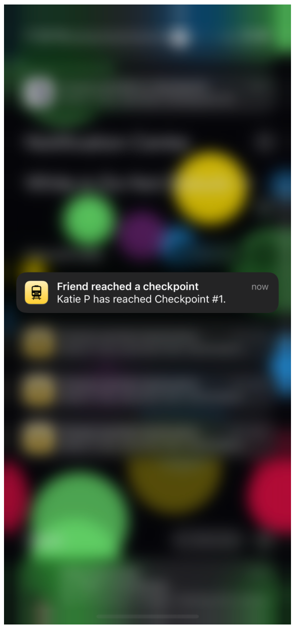
b. Rationale: Switching the way we display modes of transportation for the user to choose from makes them more visible and readily selectable. Instead of using two taps to view and select a mode of transportation, the user can now look them over and toggle between them in one tap.

3. Checkpoint Notifications



Ongoing Route To: Ray's Grill

You are near Checkpoint #3!
Should we update your TransitMate friends on your status?
Yes, update my friends
No, keep my update private



Friend reached a checkpoint
Katie P has reached Checkpoint #1.

a. [No previous screen]
b. Rationale: This is a previously-unimplemented task that we used to simulate on Figma so that testers would not have to travel to trigger the notification. The task of updating the user's route upon reaching a checkpoint is now properly working.

For a walkthrough of each task in our high-fidelity prototype V3, please see our High-Fi Video Prototype.

Considering the way our final prototype looks and functions, I would say that the lab usability study was the most valuable evaluation technique for improving our app's usability. Realizing that the home screen should be more location- or map-centered and that friends' last-shared locations are rarely used, the entire design of our home screen changed drastically. This motivated more changes throughout the app to complement the shift in the focus of the home screen. Our app would not look the way it does, or be as intuitive to use, without the insights we gained during the lab usability study.

FINAL USER INTERFACE

We present to you our full application user flows in the following pages.

The app has functionality for the following flows, all presented in the forthcoming pages:

1. Downloading the app
2. Onboarding
3. Create a New Account
4. Sign In & Reset Password
5. Create a Route
6. Checkpoint Notifications
7. Viewing a Friends Route
8. Sharing My Location to a Friend

Not included in the task flow screenshots, but also implemented are:

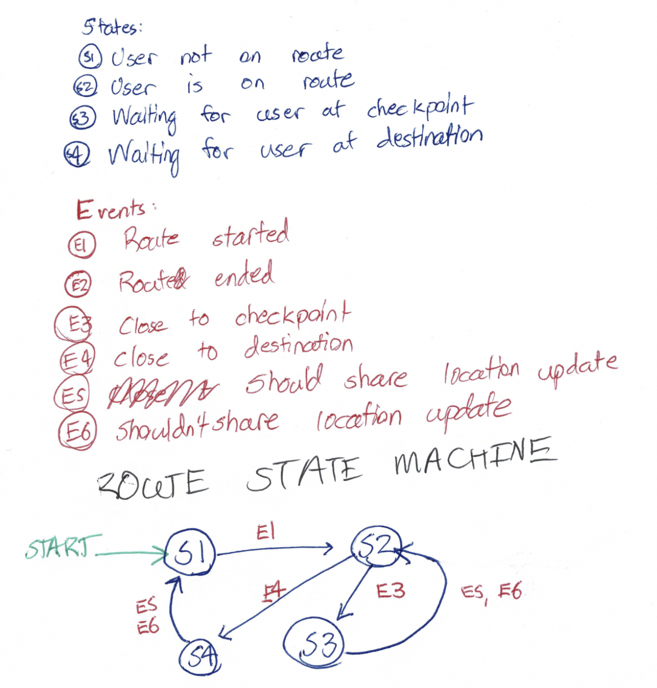
1. Requesting a Friends Location
2. Background Location Updates (so phone can be kept off)
3. Native iOS/Android Push Notifications for:
    a. Friend Requests
    b. Checkpoint Notifications From Friends
    c. Location Requests
4. Logging Out

We left a few features unimplemented, mainly a few non-critical UI components/modals as well as features like specifying/editing route followers for a particular route or editing route checkpoints after creating a route. We left such features out because of the marginal benefit of adding these features to testing the core hypotheses of our app.

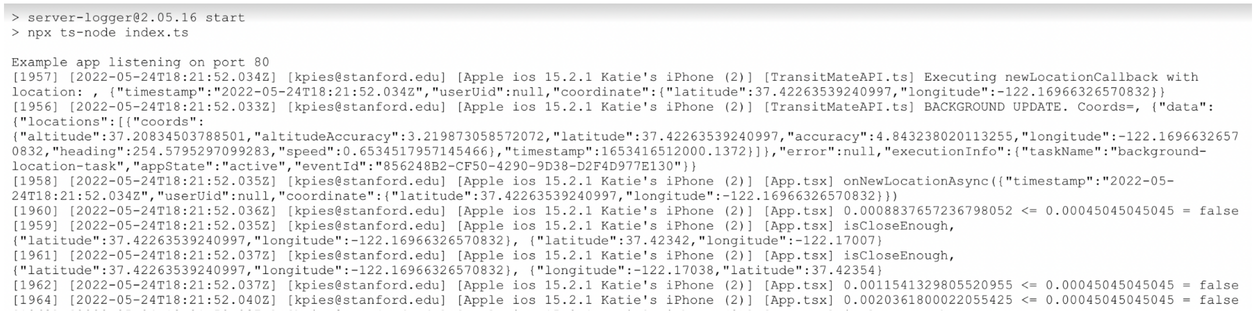
There are no Wizard of Oz features in our app: if it's there, it works (the only exception being the two safety buttons in the pull-up bottom sheet).

We used Expo and React Native for our client-side programming, Firebase for our real-time NoSQL database backend, and a low-cost Linux VM instance collecting a copious amount of user logs for debugging and clickstream analytics. For deployment and services, we used Google Play, Apple TestFlight, Expo Application Services, and Expo Push Notification Service. For development tools, we used WebStorm, Visual Studio Code, iOS Simulator for macOS, and Android Virtual Devices via Android Studio.

While the tools did not provide too much difficulty, the implementation of the checkpoint feature was very time-involved because it required the interplay of four OS subsystems in a way that persists state across React screen renders *and* between end users in real-time: notifications, background location, updating the state of the route, checking if a checkpoint is nearby and posting an event to the route's "state machine."



We made use of a liberal amount of console logging streamed to a Linux VM on Google Cloud Platform. Logs were numerous and helped debug tedious location-based route issues:

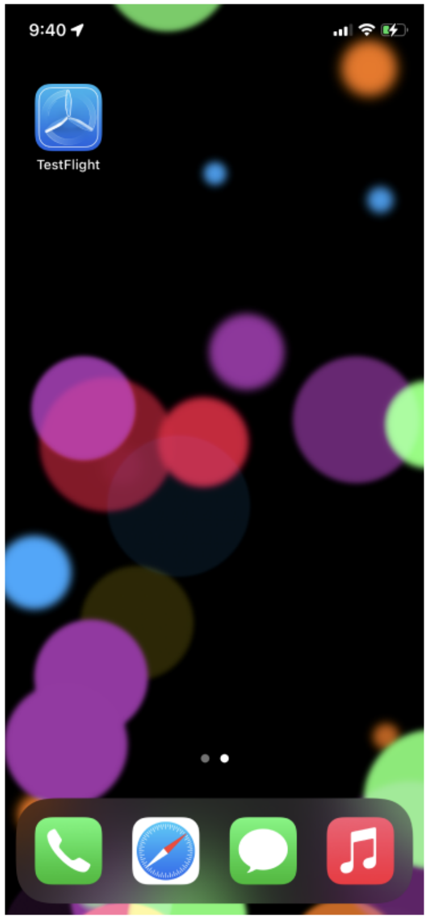

```
> server-logger@2.05.16 start
> npx ts-node index.ts

Example app listening on port 80
[1957] [2022-05-24T18:21:52.034Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [TransitMateAPI.ts] Executing newLocationCallback with
location: , {"timestamp":"2022-05-24T18:21:52.034Z","userUid":null,"coordinate":{"latitude":37.42263539240997,"longitude":-122.16966326570832}}
[1956] [2022-05-24T18:21:52.033Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [TransitMateAPI.ts] BACKGROUND UPDATE. Coords=, {"data":
{"locations":[{"coords":
{"altitude":37.20834503788501,"altitudeAccuracy":3.219873058572072,"latitude":37.42263539240997,"accuracy":4.843238020113255,"longitude":-122.1696632657
0832,"heading":254.5795297099283,"speed":0.6534517957145466},"timestamp":1653416512000.1372}]},"error":null,"executionInfo":{"taskName":"background-
location-task","appState":"active","eventId":"856248B2-CF50-4290-9D38-D2F4D977E130"}}
[1958] [2022-05-24T18:21:52.035Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] onNewLocationAsync({"timestamp":"2022-05-
24T18:21:52.034Z","userUid":null,"coordinate":{"latitude":37.42263539240997,"longitude":-122.16966326570832}})
[1960] [2022-05-24T18:21:52.036Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] 0.0008837657236798052 <= 0.00045045045045 = false
[1959] [2022-05-24T18:21:52.035Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] isCloseEnough,
{"latitude":37.42263539240997,"longitude":-122.16966326570832}, {"latitude":37.42342,"longitude":-122.17007}
[1961] [2022-05-24T18:21:52.037Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] isCloseEnough,
{"latitude":37.42263539240997,"longitude":-122.16966326570832}, {"longitude":-122.17038,"latitude":37.42354}
[1962] [2022-05-24T18:21:52.037Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] 0.0011541329805520955 <= 0.00045045045045 = false
[1964] [2022-05-24T18:21:52.040Z] [kpies@stanford.edu] [Apple ios 15.2.1 Katie's iPhone (2)] [App.tsx] 0.0020361800022055425 <= 0.00045045045045 = false
```

Our README for v3: High-Fi Prototype V3 README

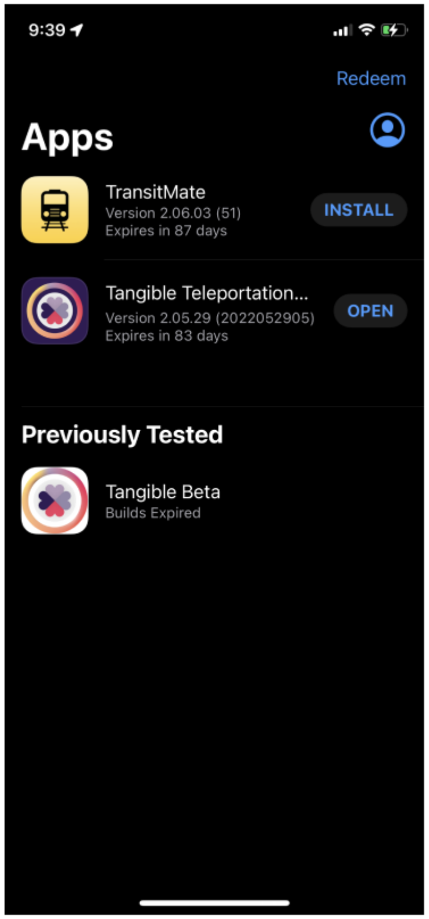
The app is in the final review stages to join the Apple App Store for iPhones. It is already published on the Google Play Store for Android.

Downloading The App

Download TestFlight



Get Invite & Install TransitMate


9:39

Redeem

Apps

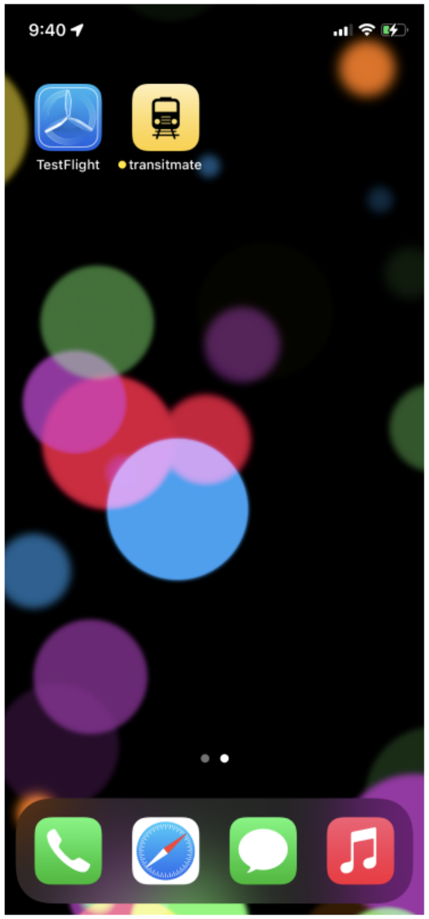
TransitMate
Version 2.06.03 (51)
Expires in 87 days
INSTALL

Tangible Teleportation...
Version 2.05.29 (2022052905)
Expires in 83 days
OPEN

Previously Tested

Tangible Beta
Builds Expired

Profit

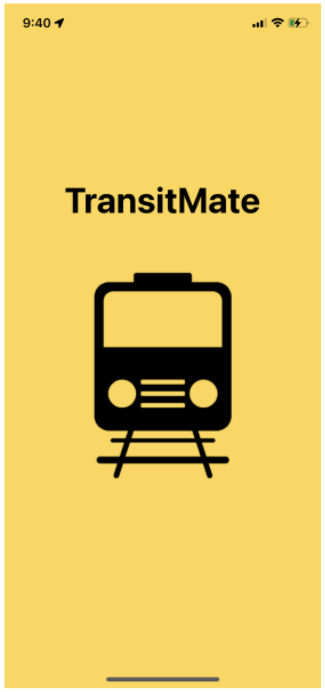


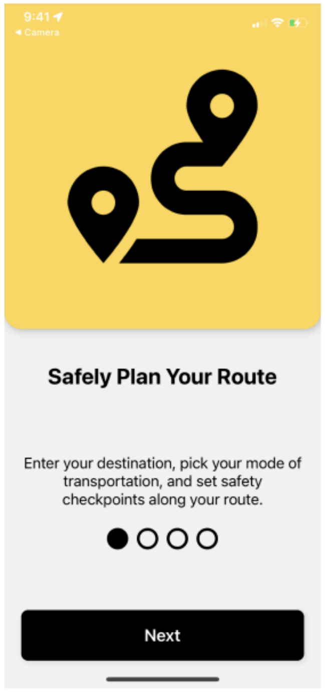
App “Splash Screen” & Onboarding

App “Splash Screen”
(while OS loads app)

Onboarding Screens with GIF video (second slide)

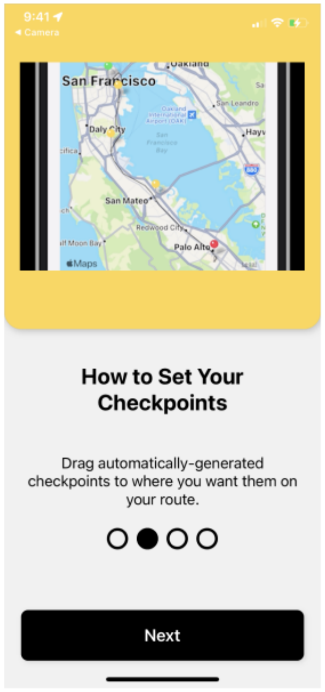
Sign In Screens (next)





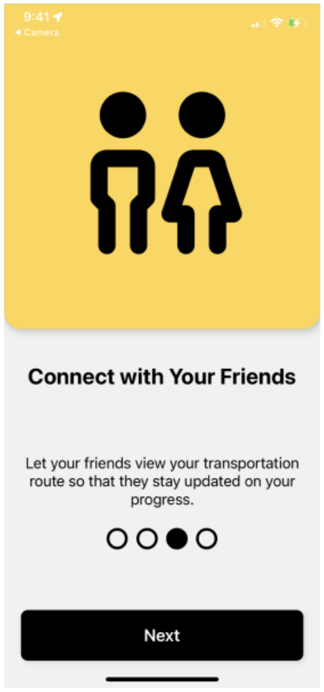
Safely Plan Your Route

Enter your destination, pick your mode of transportation, and set safety checkpoints along your route.



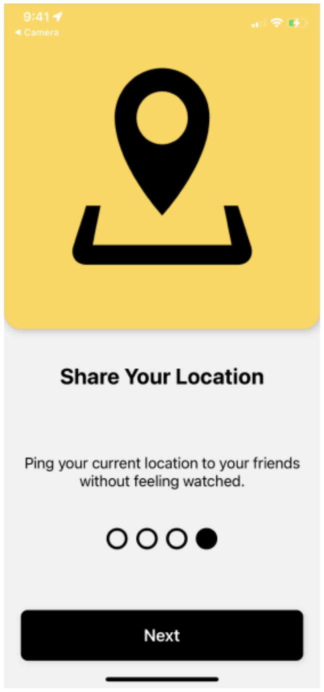
How to Set Your Checkpoints

Drag automatically-generated checkpoints to where you want them on your route.



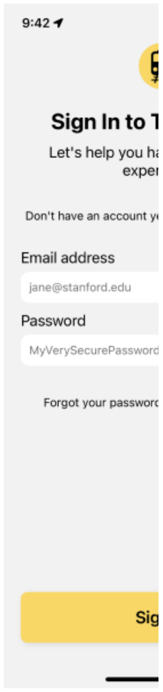
Connect with Your Friends

Let your friends view your transportation route so that they stay updated on your progress.



Share Your Location

Ping your current location to your friends without feeling watched.



Sign In to T

Let's help you ha
exper

Don't have an account y

Email address

jane@stanford.edu

Password

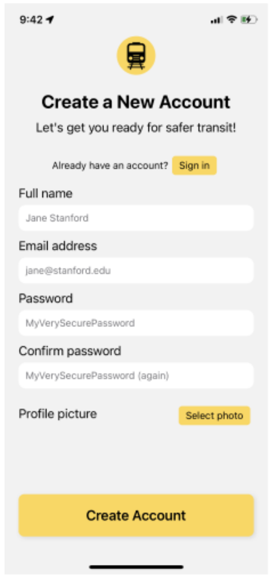
MyVerySecurePassword

Forgot your passwor

Create a New Account

Profile photo selected from photo library

Field-level, client-side validation of form fields


9:42

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Jane Stanford

Email address

jane@stanford.edu

Password

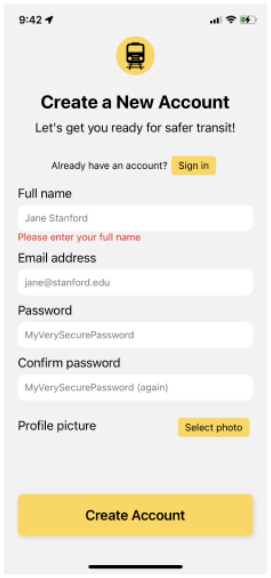
MyVerySecurePassword

Confirm password

MyVerySecurePassword (again)

Profile picture Select photo

Create Account


9:42

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Jane Stanford

Please enter your full name

Email address

jane@stanford.edu

Password

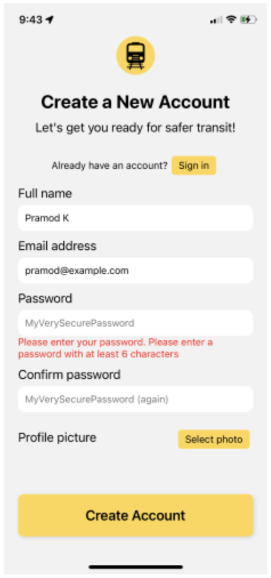
MyVerySecurePassword

Confirm password

MyVerySecurePassword (again)

Profile picture Select photo

Create Account


9:43

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Pramod K

Email address

pramod@example.com

Password

MyVerySecurePassword

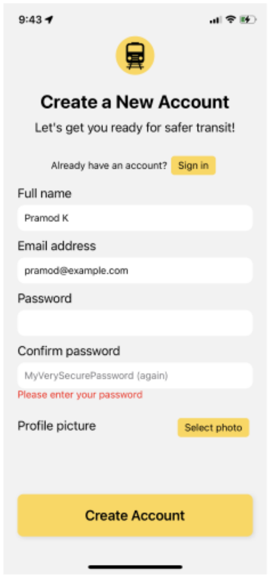
Please enter your password. Please enter a password with at least 6 characters

Confirm password

MyVerySecurePassword (again)

Profile picture Select photo

Create Account


9:43

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Pramod K

Email address

pramod@example.com

Password

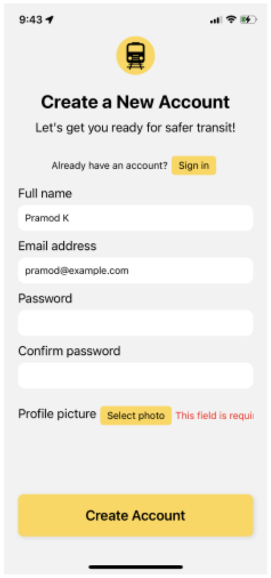
Confirm password

MyVerySecurePassword (again)

Please enter your password

Profile picture Select photo

Create Account


9:43

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Pramod K

Email address

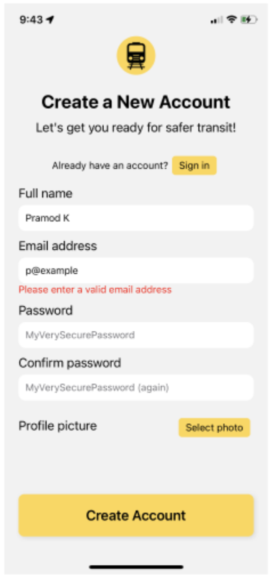
pramod@example.com

Password

Confirm password

Profile picture Select photo This field is requi

Create Account


9:43

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Pramod K

Email address

p@example

Please enter a valid email address

Password

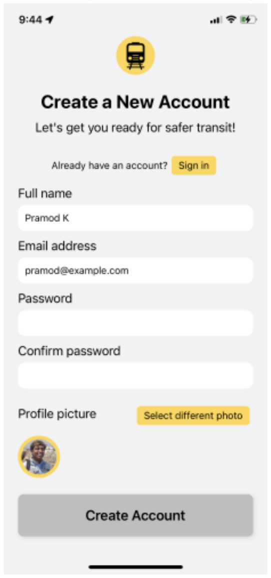
MyVerySecurePassword

Confirm password

MyVerySecurePassword (again)

Profile picture Select photo

Create Account


9:44

Create a New Account

Let's get you ready for safer transit!

Already have an account? Sign in

Full name

Pramod K

Email address

pramod@example.com

Password

Confirm password

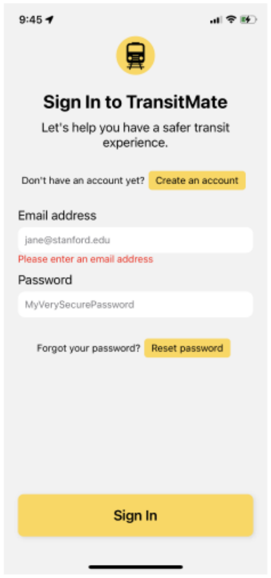
Profile picture Select different photo

Create Account

"Create Account" button is disabled

Sign In + Reset Password

Field-level, client-side validation of form fields


9:45

Sign In to TransitMate

Let's help you have a safer transit experience.

Don't have an account yet? Create an account

Email address

jane@stanford.edu

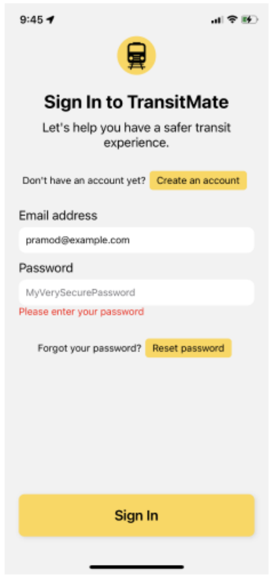
Please enter an email address

Password

MyVerySecurePassword

Forgot your password? Reset password

Sign In


9:45

Sign In to TransitMate

Let's help you have a safer transit experience.

Don't have an account yet? Create an account

Email address

pramod@example.com

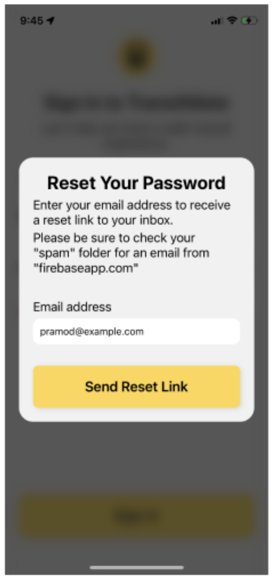
Password

MyVerySecurePassword

Please enter your password

Forgot your password? Reset password

Sign In


9:45

Reset Your Password

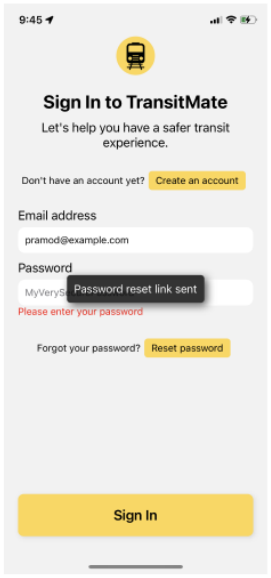
Enter your email address to receive a reset link to your inbox.

Please be sure to check your "spam" folder for an email from "firebaseapp.com"

Email address

pramod@example.com

Send Reset Link


9:45

Sign In to TransitMate

Let's help you have a safer transit experience.

Don't have an account yet? Create an account

Email address

pramod@example.com

Password

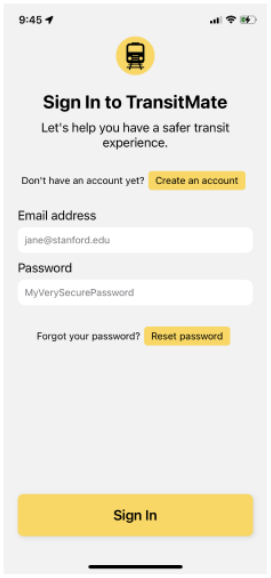
MyVeryS

Password reset link sent

Please enter your password

Forgot your password? Reset password

Sign In


9:45

Sign In to TransitMate

Let's help you have a safer transit experience.

Don't have an account yet? Create an account

Email address

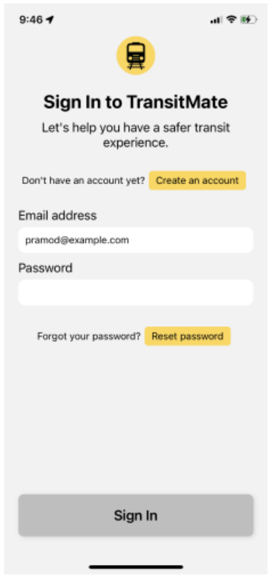
jane@stanford.edu

Password

MyVerySecurePassword

Forgot your password? Reset password

Sign In


9:46

Sign In to TransitMate

Let's help you have a safer transit experience.

Don't have an account yet? Create an account

Email address

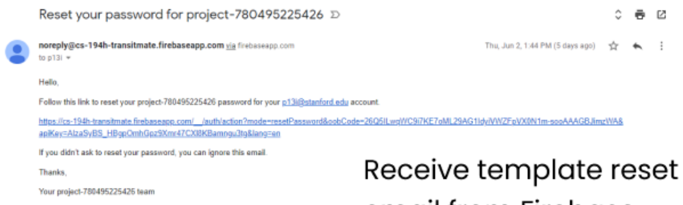
pramod@example.com

Password

Forgot your password? Reset password

Sign In

Email already entered previously is pre-populated into reset link


Reset your password for project-780495225426

noreply@cs-194h-transitmate.firebaseapp.com via firebaseapp.com

to p13i

Thu, Jun 2, 1:44 PM (5 days ago)

Hello,

Follow this link to reset your project-780495225426 password for your p13i@stanford.edu account.

https://cs-194h-transitmate.firebaseapp.com/__/auth/action?mode=resetPassword&oobCode=26Q5ILwqWC9i7KE7oML29AG1ldyiVWZFpVX0N1m-sooAAAGBJimzWA&apiKey=AIzaSyBS_HBgpOmhGpz9Xmr47CX8KBamngu3tg&lang=en

If you didn't ask to reset your password, you can ignore this email.

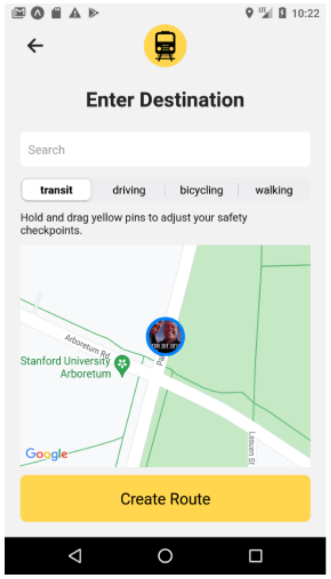
Thanks,

Your project-780495225426 team

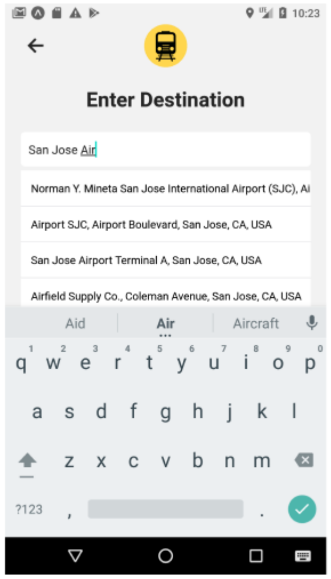
Receive template reset email from Firebase

Create A Route (Task #3)

Auto-fill from Google Maps Search API



Hold and drag yellow pins to adjust your safety checkpoints.



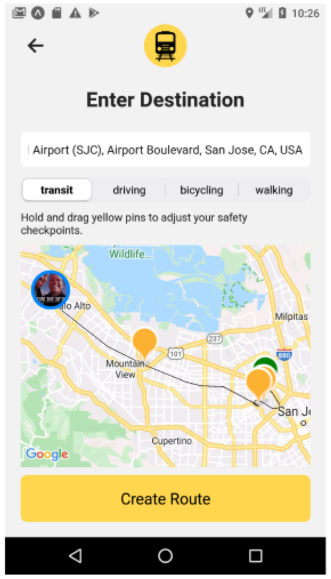
San Jose Air

Norman Y. Mineta San Jose International Airport (SJC), Ai

Airport SJC, Airport Boulevard, San Jose, CA, USA

San Jose Airport Terminal A, San Jose, CA, USA

Airfield Supply Co., Coleman Avenue, San Jose, CA, USA

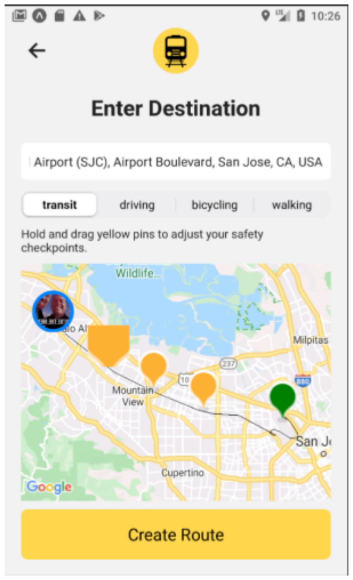


Airport (SJC), Airport Boulevard, San Jose, CA, USA

Hold and drag yellow pins to adjust your safety checkpoints.

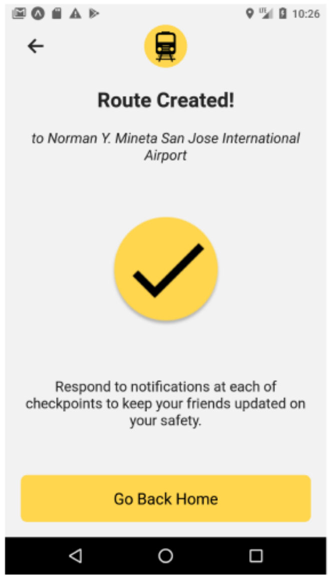
Routes downloaded from Google Routes API

Pins can be dragged and ropped (growing larger under the user's finger)



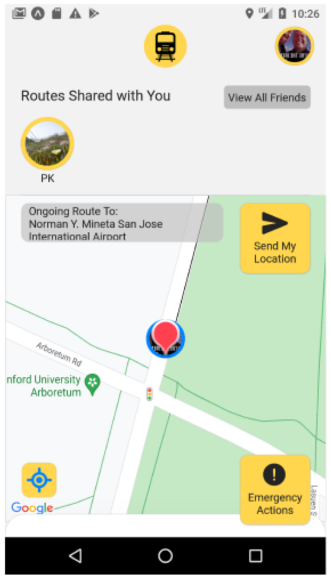
Airport (SJC), Airport Boulevard, San Jose, CA, USA

Hold and drag yellow pins to adjust your safety checkpoints.



to Norman Y. Mineta San Jose International Airport

Respond to notifications at each of checkpoints to keep your friends updated on your safety.

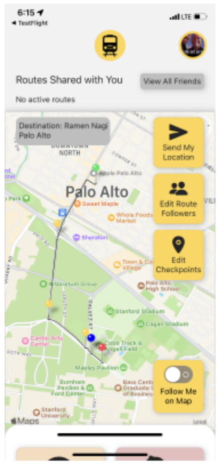


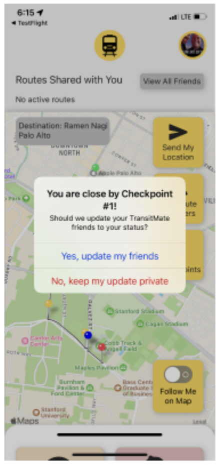
Ongoing Route To: Norman Y. Mineta San Jose International Airport

Taken back to home page showing user on route

Checkpoint Notifications (as of May 16)

Started a route from around athletic fields to Ramen Nagi in Palo Alto



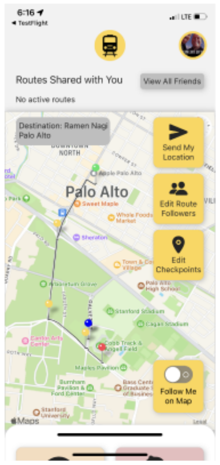


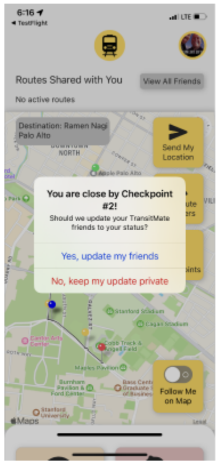
You are close by Checkpoint #1!

Should we update your TransitMate friends to your status?

Yes, update my friends

No, keep my update private





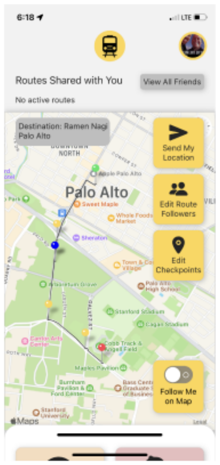
You are close by Checkpoint #2!

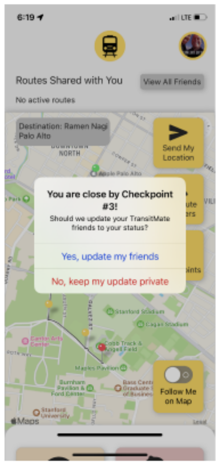
Should we update your TransitMate friends to your status?

Yes, update my friends

No, keep my update private

Current location got within 50 meters of Checkpoint #1.



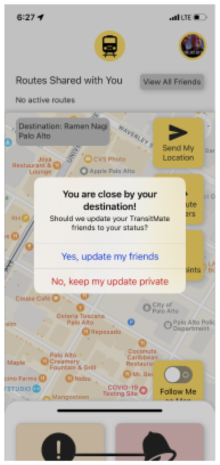


You are close by Checkpoint #3!

Should we update your TransitMate friends to your status?

Yes, update my friends

No, keep my update private



You are close by your destination!

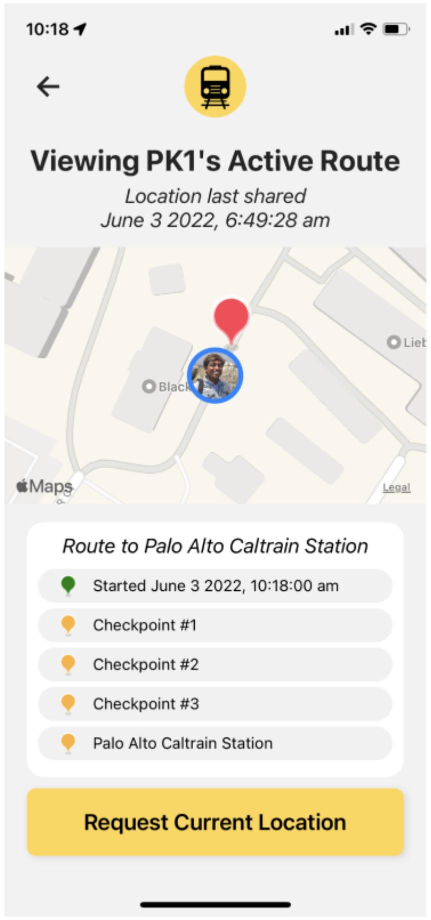
Should we update your TransitMate friends to your status?

Yes, update my friends

No, keep my update private

When within 50 meters of the destination, we get another alert.

View a Friend's Route


10:18

Viewing PK1's Active Route

Location last shared
June 3 2022, 6:49:28 am

Route to Palo Alto Caltrain Station

Started June 3 2022, 10:18:00 am

Checkpoint #1

Checkpoint #2

Checkpoint #3

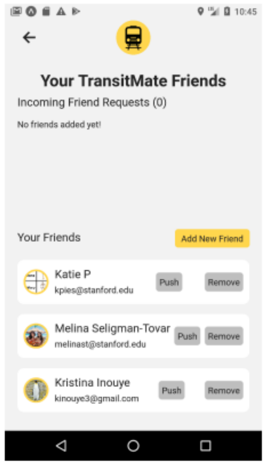
Palo Alto Caltrain Station

Request Current Location

Checkpoints update with timestamps as user progresses along their route

Add a Friend

Send a friend request


10:45

Your TransitMate Friends

Incoming Friend Requests (0)

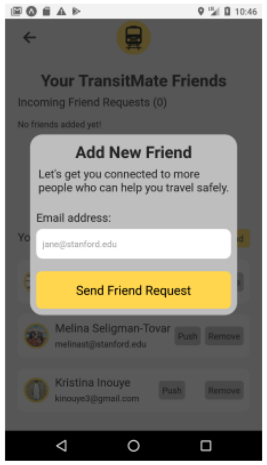
No friends added yet!

Your Friends — Add New Friend

Katie P, kpies@stanford.edu — Push, Remove

Melina Seligman-Tovar, melinast@stanford.edu — Push, Remove

Kristina Inouye, kinouye3@gmail.com — Push, Remove

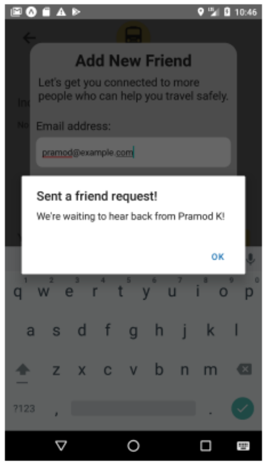

10:46

Add New Friend

Let's get you connected to more people who can help you travel safely.

Email address: jane@stanford.edu

Send Friend Request


10:46

Add New Friend

Let's get you connected to more people who can help you travel safely.

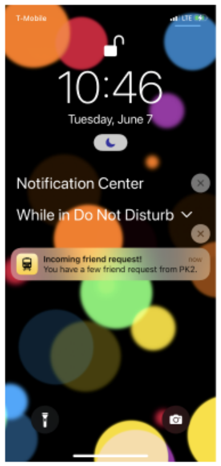
Email address: pramod@example.com

Sent a friend request!

We're waiting to hear back from Pramod K!

OK

Recipient gets notification


T-Mobile

10:46

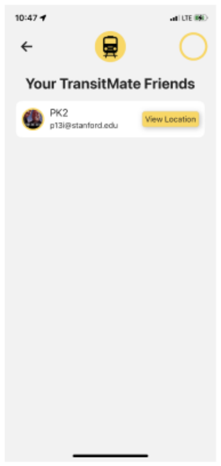
Tuesday, June 7

Notification Center

While in Do Not Disturb

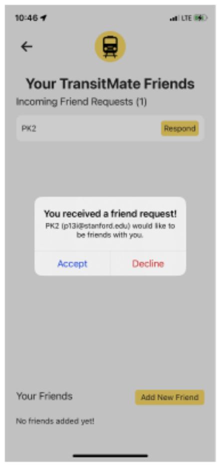
Incoming friend request! now

You have a few friend request from PK2.


10:47

Your TransitMate Friends

PK2, p13i@stanford.edu — View Location


10:46

Your TransitMate Friends

Incoming Friend Requests (1)

PK2 — Respond

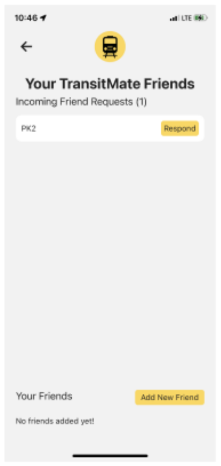
You received a friend request!

PK2 (p13i@stanford.edu) would like to be friends with you.

Accept — Decline

Your Friends — Add New Friend

No friends added yet!


10:46

Your TransitMate Friends

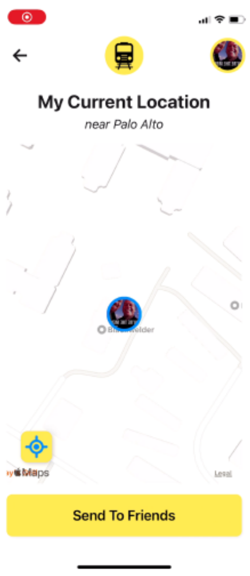
Incoming Friend Requests (1)

PK2 — Respond

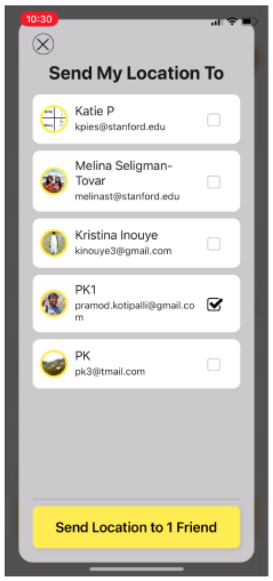
Your Friends — Add New Friend

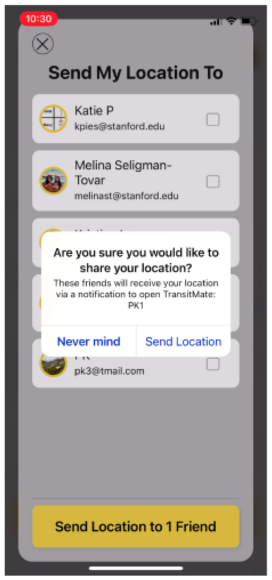
No friends added yet!

Sharing Location with Friend



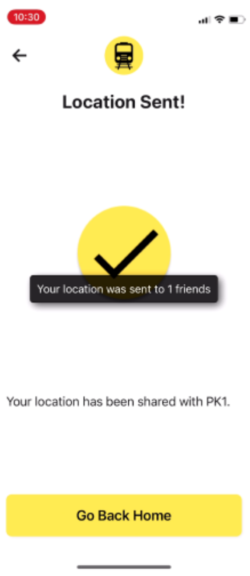
Send your location to a set of friends





Are you sure you would like to share your location?
These friends will receive your location via a notification to open TransitMate: PK1

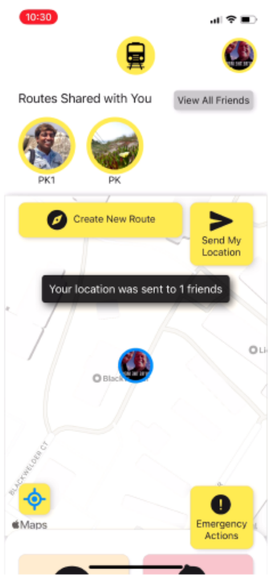
Toast notification confirms



Your location was sent to 1 friends

Your location has been shared with PK1.

Toast persists across screens



Your location was sent to 1 friends

MAKING IT REAL

The team, left to right: Amber, Shina, Katie, and Pramod

We are a group of Stanford students studying Computer Science, Management Science and Engineering and Symbolic Systems. Hailing from Long Island, New York; Seattle, Washington; Waipahu, Hawaii; and Los Angeles, California, we have lived experience navigating a wide variety of transit systems. Our team members have professional experience in design, development and project management. Over the past six months, we have spoken to dozens of real-world travelers, commuters, and safety-conscious parents and their children.

We believe that this product will appeal to safety-focused yet privacy-minded travelers such as commuters, young adult friend groups, and parents and their older children. While a variety of transit- and safety-focused applications such as Find My Friends and Life 360 already exist, none has Transitmate's unique combination of safety, privacy, and communication enabled by our checkpoint-based route system, non-continuous sharing, and friend network.

We see several opportunities to bring this product to market, including two potential revenue streams. The first is to adapt our design, particularly the checkpoint notification and route sharing systems, into an SDK that can be integrated into existing map apps, such as Google Maps or Apple Maps, or into transit apps run by major cities like New York and Los Angeles. Additionally, we could offer opportunities for businesses along frequently traveled routes to advertise through our app; for example, a coffee shop at a train station could send an invitation to nearby users through the app as a safe location. In the long term, we see the potential for an extremely wide customer base; anyone who travels or commutes would have use for our design.

SUMMARY

TransitMate is not only a way for concerned friends and family members to keep track of someone they care about who is using public transportation alone—it is a way for public transportation users to feel less afraid and more confident with the knowledge that someone is always within reach and checking in on their safety and trip progress without being able to follow every step they take. Even when not using public transportation, people can ask for each other’s whereabouts in a way that does not pressure each other to respond. Both sides would know that the recipient of a location request is able to decline to share their location if they just don’t want to at that moment. One of TransitMate’s core values is safety, but another is privacy, which other location-sharing and safety-based apps do not prioritize. It may be a difficult balance to strike, but we believe that TransitMate can get this right and provide people with a way to feel comfortable when traveling or seeing their loved ones make their own trips.

APPENDIX