Design Document for Mobile App

Bus Talent

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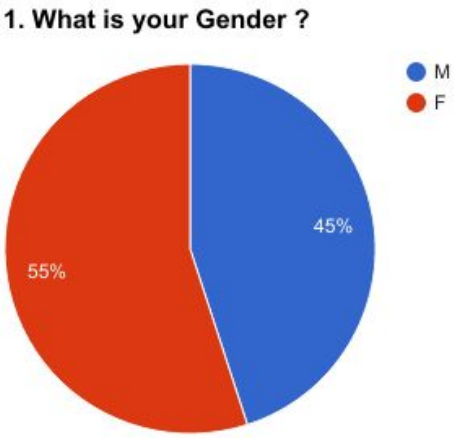
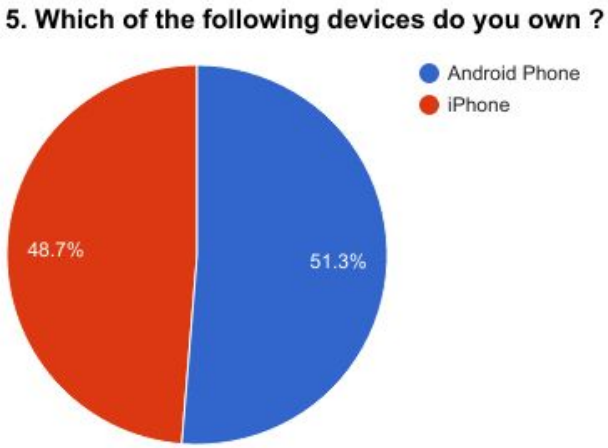
User Survey

User Demographic and Environment

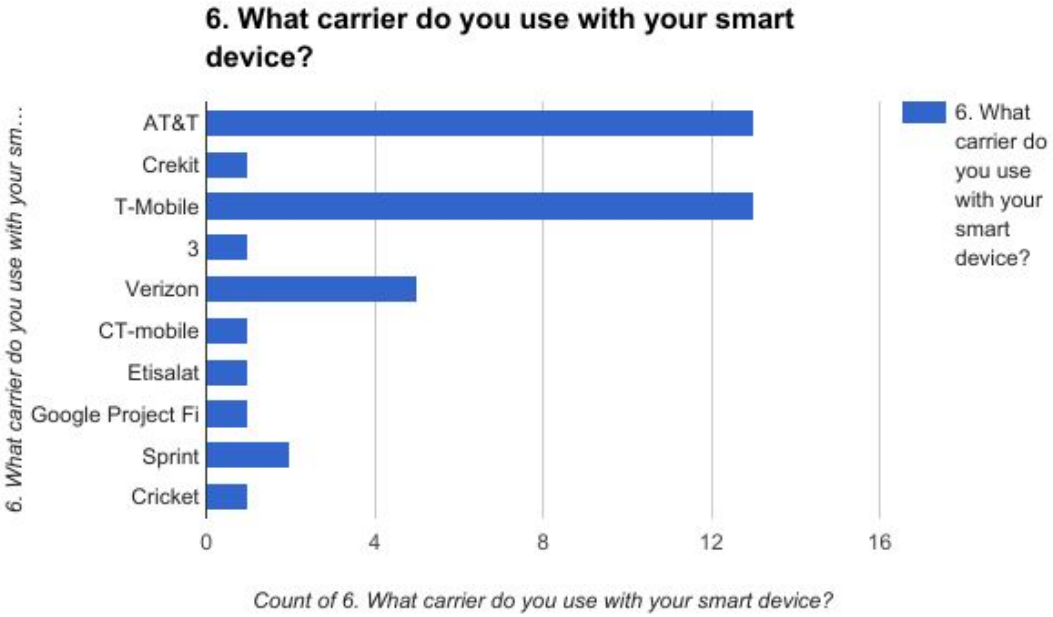


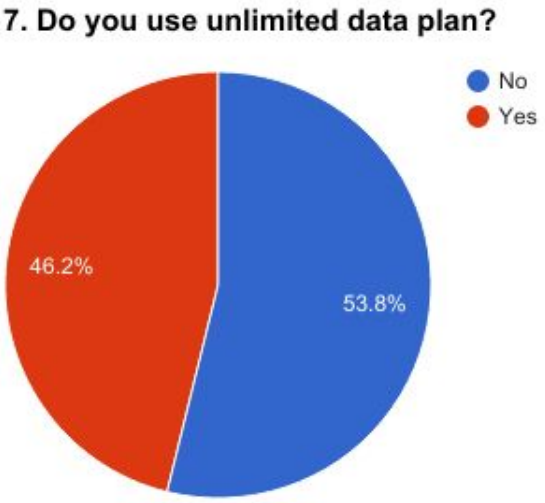
39 users, based in Pittsburgh, with a 11:9 ratio of women:men were interviewed for the purpose of our survey. Users took their bus from various bus stops such as Liberty & 6th, Fifth & Atwood and Forbes & Murray to name a popular few, which is where the site surveys were done.

Mobile Phones they own, Carriers they use, Data plans and Alert Preferences

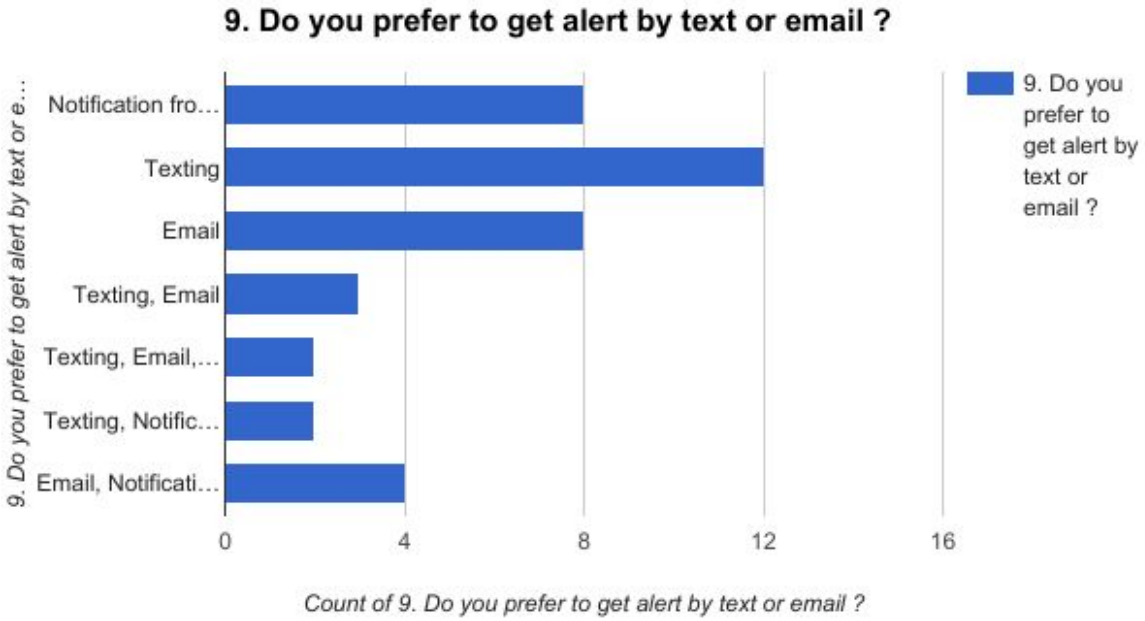


From our Survey results, we inferred that on an average, there are more Android phone owners than iPhone owners. It is one of the reasons, we are going ahead with implementing our prototype in Android. Three-Fourths of the users primarily used either of AT&T, T-Mobile or Verizon as their carriers.

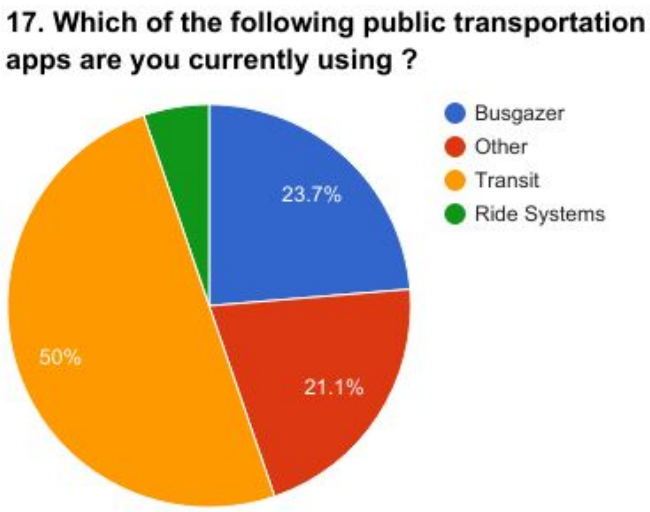




A little less than half of the users have an unlimited data plan on their carriers. Among those who don't, majority of the users opt for 2-4 GB data plan. 30% of the users surveyed preferred receiving alerts through texts, while about 20% each preferred receiving alerts through email and notification from the app respectively.



User's Commute App Preferences



About 50% of the users surveyed use Transit app for assisting with their commute, while about 25% use Busgazer as their primary app. From our surveys we collated the features of the commute app that the users like and dislike, which is presented below:

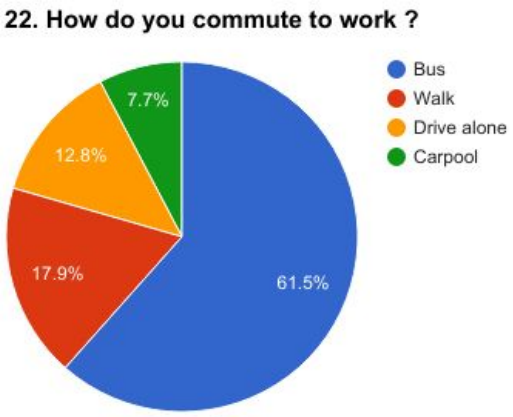
The Features they liked were:

- Clean and simple interface.
- Last Bus Timing
- InBound and OutBound info.
- 24 hr schedule of the buses.
- Time of Arrival is sorted.
- Bookmarking a stop.

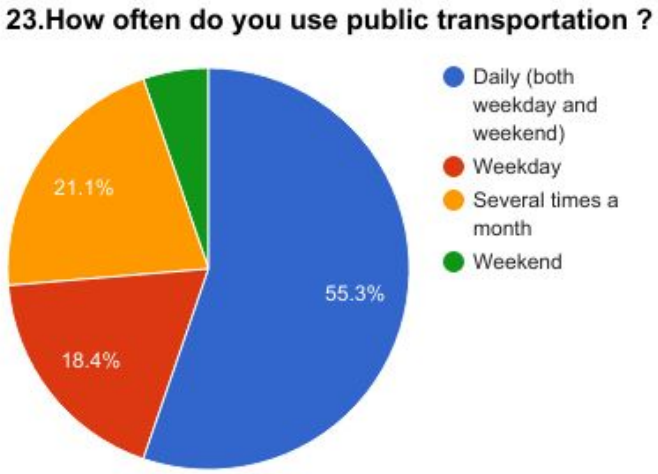
Their major pain points were:

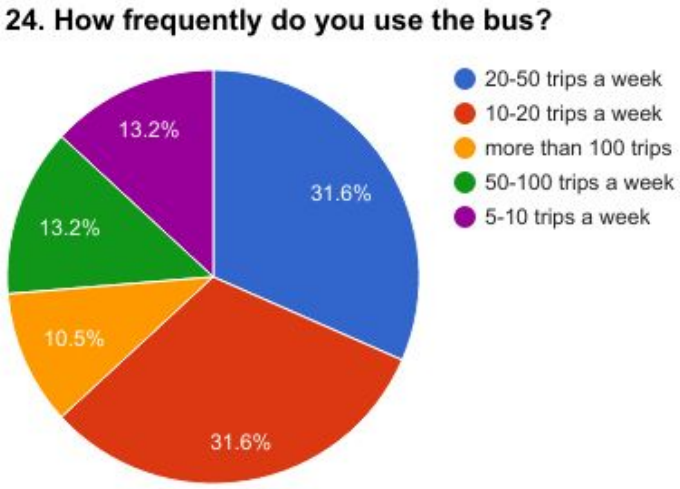
- No texts, only icons on the home screen
- Non adjustable font size of the timings and bus names.
- No instruction walk through of how to use the app
- Inaccurate timing and location sensing.
- Uber ads in between bus timings
- The app is slow to launch/respond.

User's Bus Riding Habits

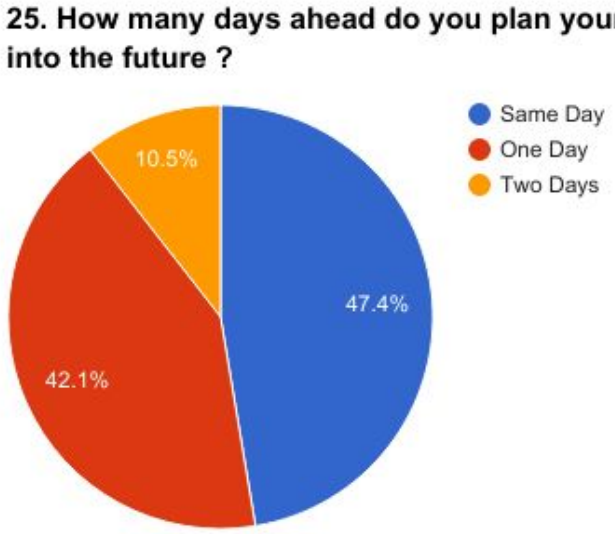


About 60% of the users surveyed commuted to their workplace via a bus. About 55% of the users use the bus not just during the week but also during the weekend, while close to 20% of them use it only during the weekdays.

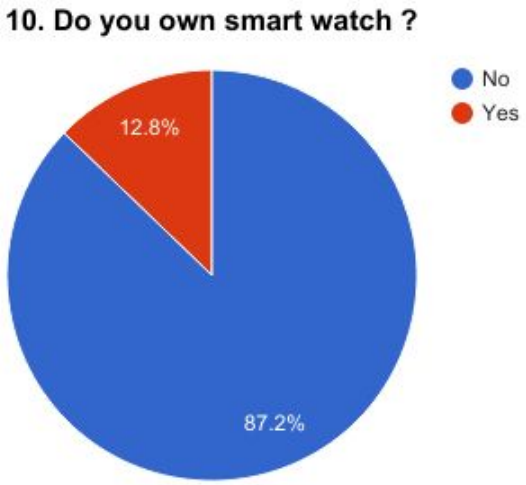




About 60% of the users travel 10-50 trips a week using the public transportation. Nearly 90% of the users are accustomed to planning their trips either on the same day or one day ahead.



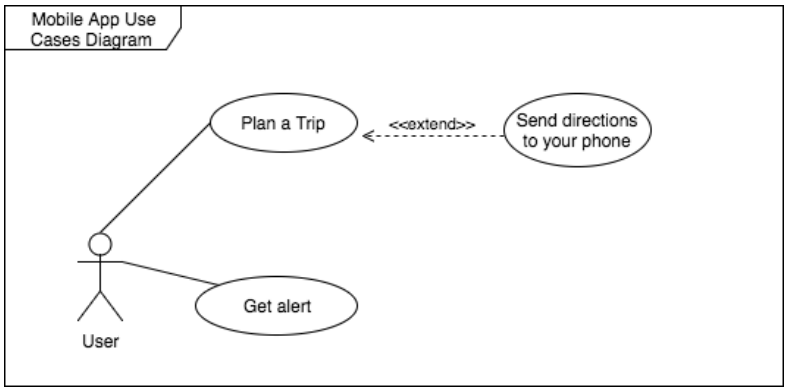
5.Smart Watch Users



About 13 % of our respondents, own a smartwatch, thus there is a non negligible share of potential customers who can be alerted through smartwatch notifications of the bus arrival.

Primary Use Case

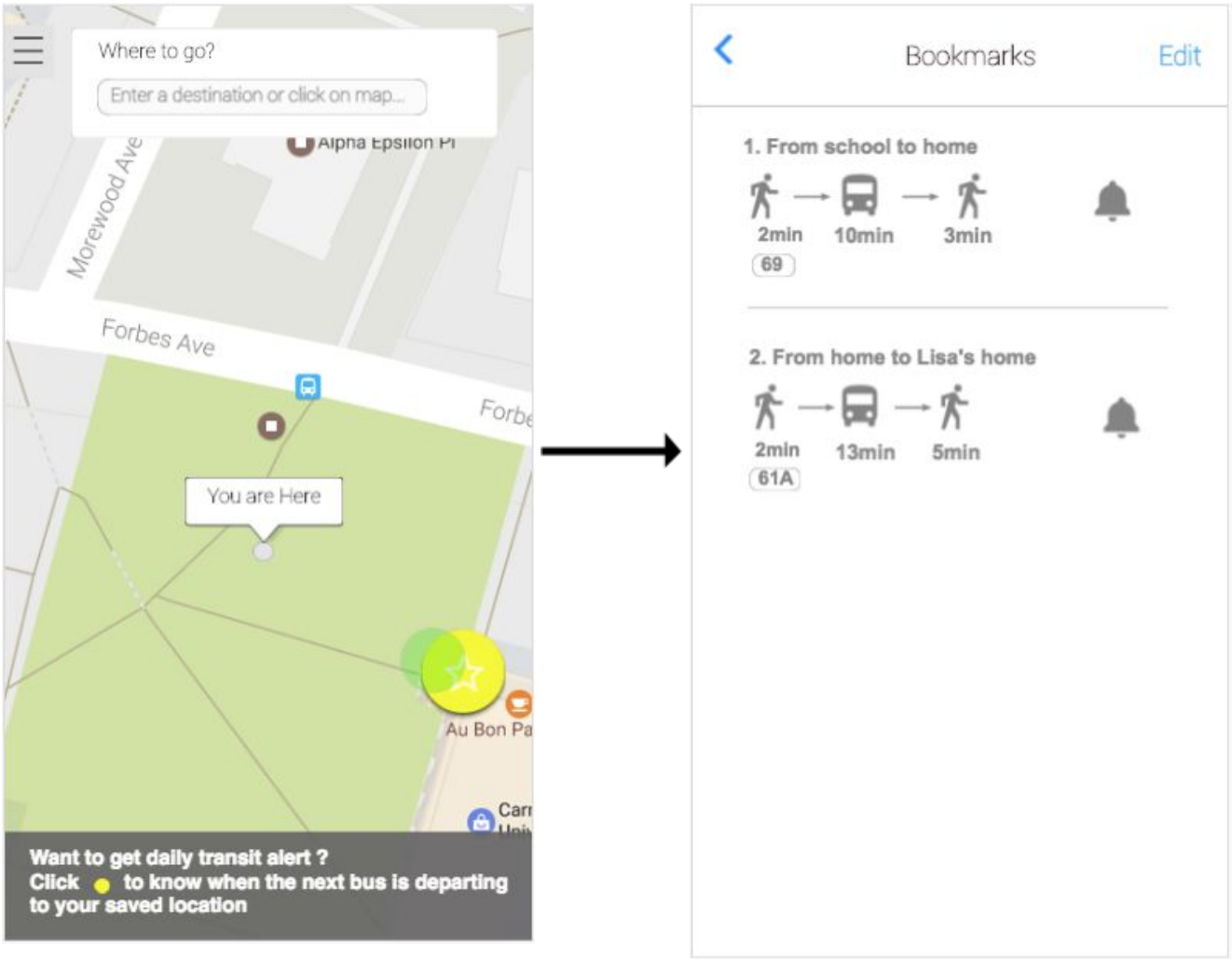
The Bus Talent mobile application aims at providing PAAC riders with functionality roughly equivalent to that supported by PAAC current website. It is important to create features which cater more use cases with the present data available. We have identified the two primary features for PAAC users: trip planner and trip alert. The trip planner use case begins when the PAAC users do not know the navigation of where they want to go. The users can enter the destination address and then system will initially return the best route recommendation for PAAC riders, while the users are able to view other trip options by choosing corresponding actions. What's more, the trip planner use case includes indicating the origin and destination of the trip along with the desired date and time of arrival. We designed a optional "send directions to your phone" use case that extends the base use case and adds more functionality to the system. The second use case is next bus alert. The users will receive the automated alert for their favorites routes, while they can check the real-time bus updates on selected routes.



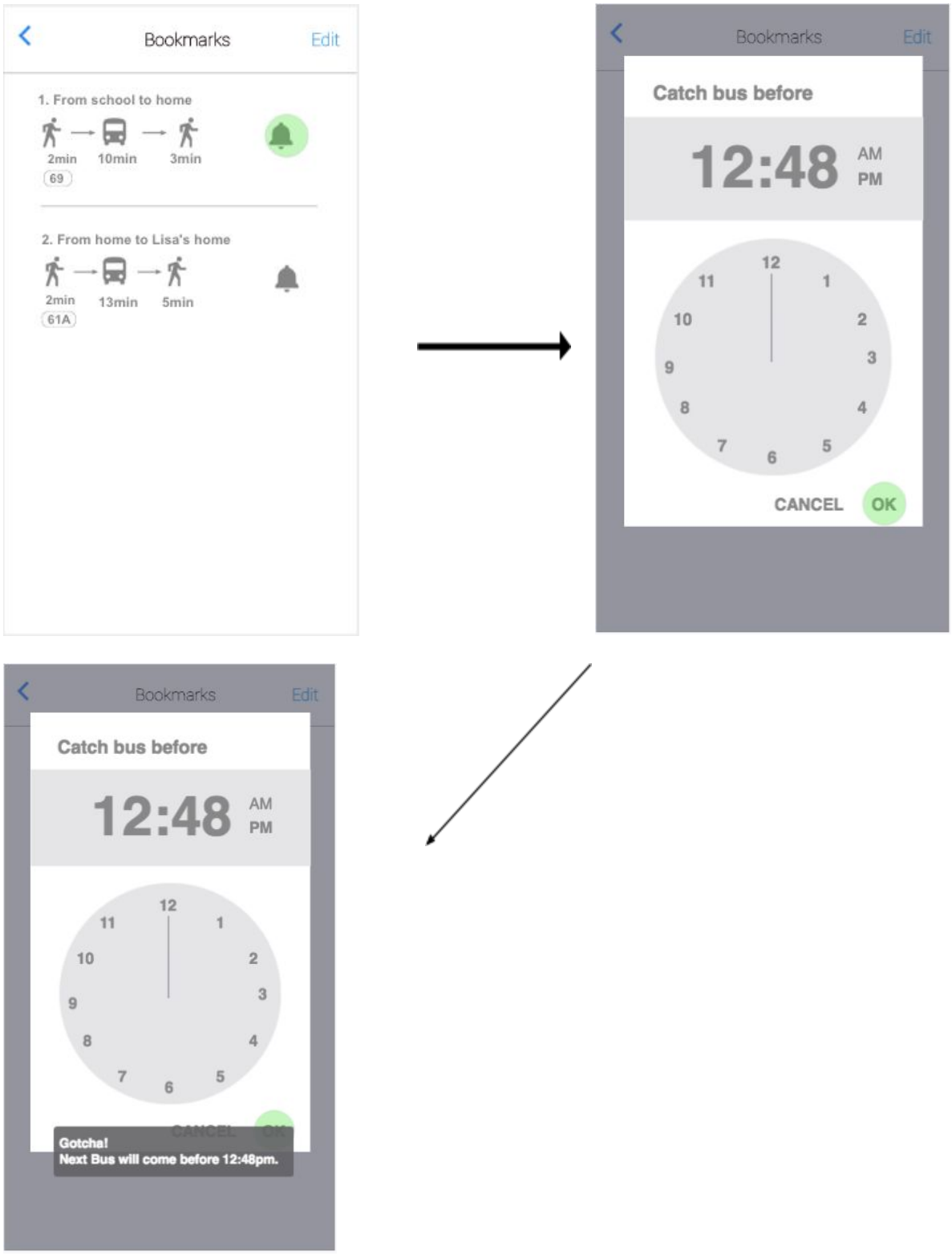
User Case 1	Trip Planning
Actor	PAAC riders
Precondition	• The PAAC riders have already installed the Bus Talent app. • The users allow the mobile app to access their location while they use the app. • The users do not know how to get where they're going.
Basic Flow	1. User inputs the destination address, the system will automatically plan the best available route for users based on their current location by default. 2. System returns a snippet of best route recommendation with bus mode. User can either choose to view trip detail of recommended route or view more trip options. 3. If user would like to view complete trip information of recommended route, they click "trip details" link and then the system will return the detailed information. 4. If users would like to view other trip options, they click "view other route options" and then the system will return the results of all available trips which are sorted by arrival time in default. The users can sort the results by select other attributes such as: minimal walking, fewer transfers, and price. 5. User can select desired date and time for arriving by or departing at certain time.
User Interface	In wireframes, the green circle indicates where the user touch on screen

User Case 2	Get trip alert
Actor	PAAC riders
Precondition	• The users have installed the Bus Talent app. • The users allow the mobile app to access their location while they use the app. • The users would like to save their favorite trip route and get alert of next bus time in advance.
Basic Flow	1. If user already saved favorite route, user can click the floating icon of bookmark on the main page, then system will return a list of saved trips. 2. User click the bell icon to set the alert time, the system will pop a window for setting the departure time. 3. User click ok after confirming the departure time, the system will return a window for setting the reminder time before the departure time. 4. User will receive a notification at the reminder time he/she set before the departure time.
User Interface	In wireframes, the green circle indicates where the user touch on screen

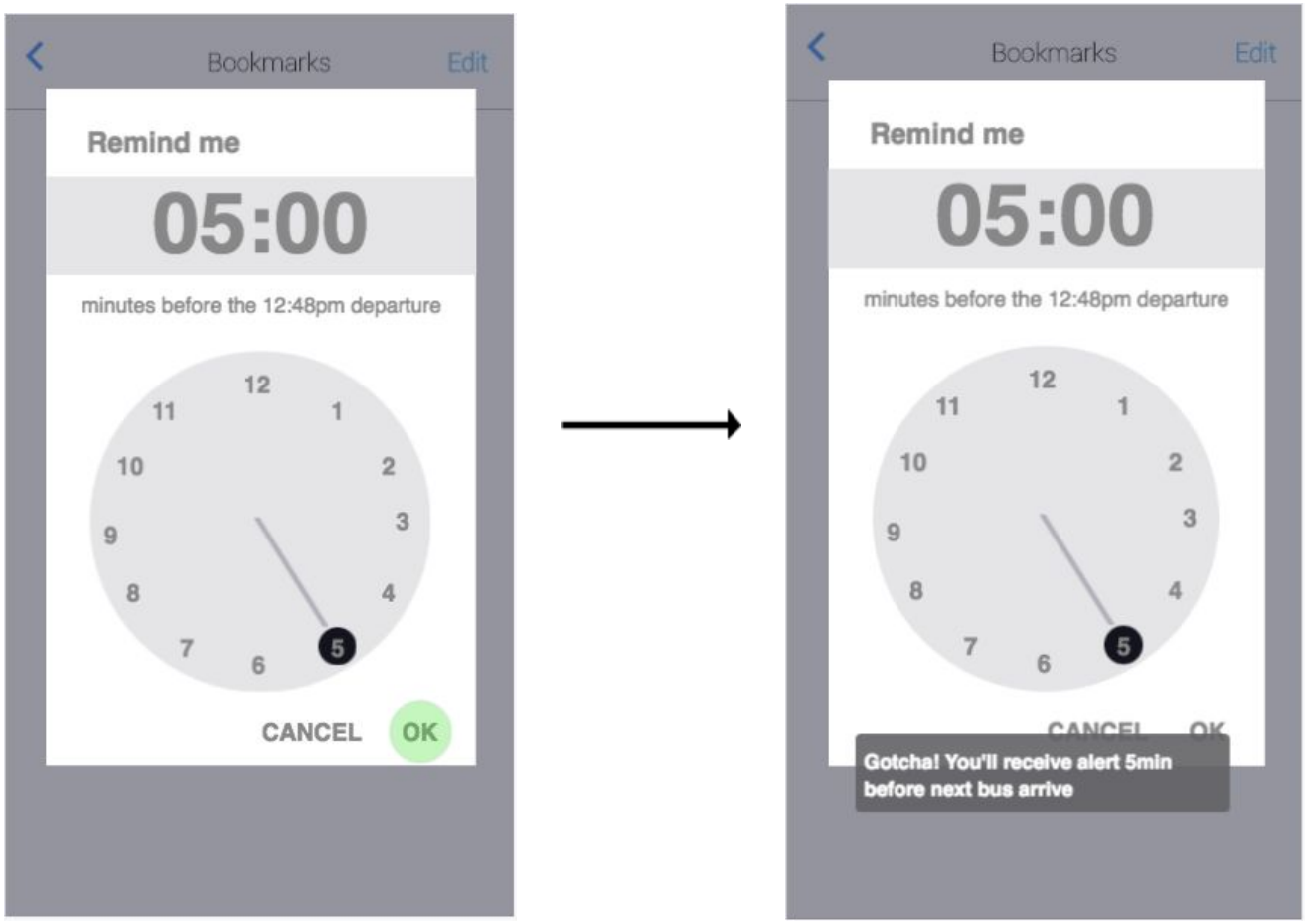
Flow #1


Where to go?
Enter a destination or click on map...
Morewood Ave
Alpha Epsilon Pi
Forbes Ave
You are Here
Au Bon Pa
Want to get daily transit alert ?
Click to know when the next bus is departing to your saved location
Bookmarks
Edit
1. From school to home
2min
10min
3min
69
2. From home to Lisa's home
2min
13min
5min
61A

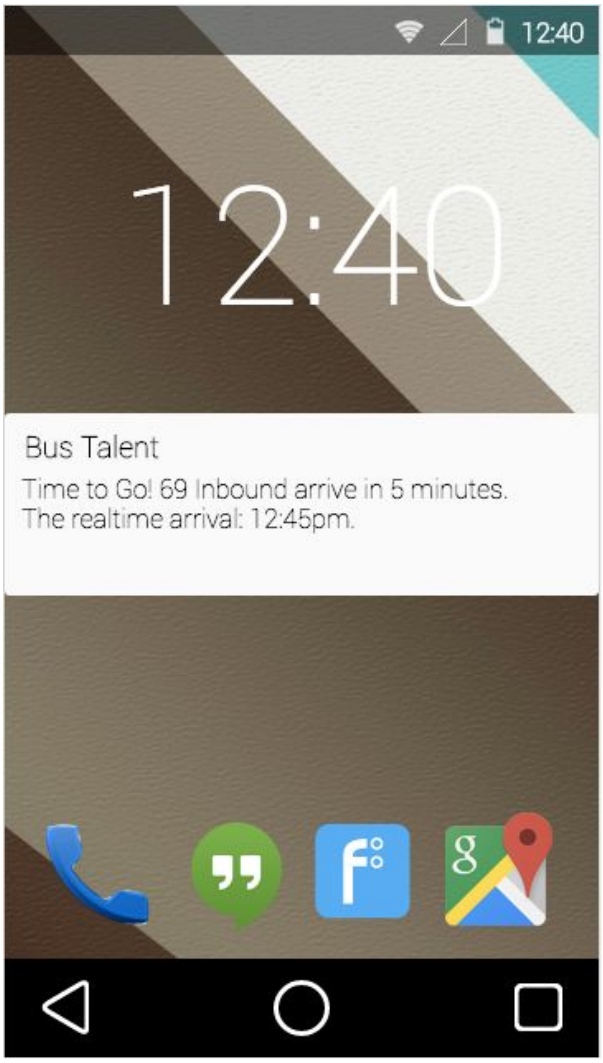
Flow #2:


Bookmarks
Edit
1. From school to home
2min
10min
3min
69
2. From home to Lisa's home
2min
13min
5min
61A
Bookmarks
Edit
Catch bus before
12:48
AM
PM
12
1
2
3
4
5
6
7
8
9
10
11
CANCEL
OK
Bookmarks
Edit
Catch bus before
12:48
AM
PM
CANCEL
OK
Gotcha!
Next Bus will come before 12:48pm.

Flow #3:

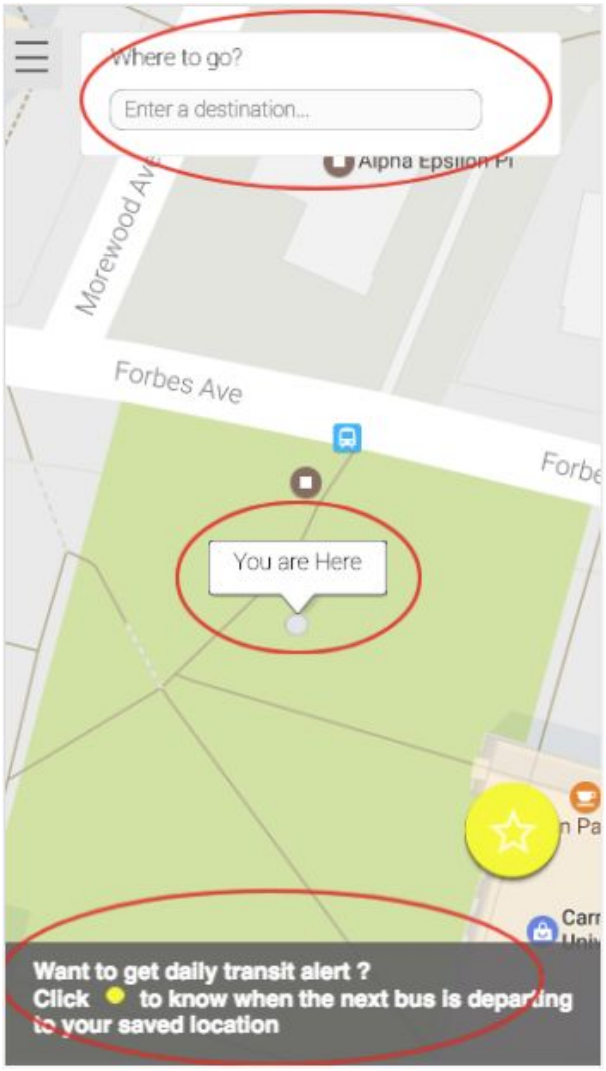

Bookmarks
Edit
Remind me
05:00
minutes before the 12:48pm departure
12
1
2
3
4
5
6
7
8
9
10
11
CANCEL
OK
Bookmarks
Edit
Remind me
05:00
minutes before the 12:48pm departure
Gotcha! You'll receive alert 5min before next bus arrive

Flow #4:


12:40
12:40
Bus Talent
Time to Go! 69 Inbound arrive in 5 minutes.
The realtime arrival: 12:45pm.

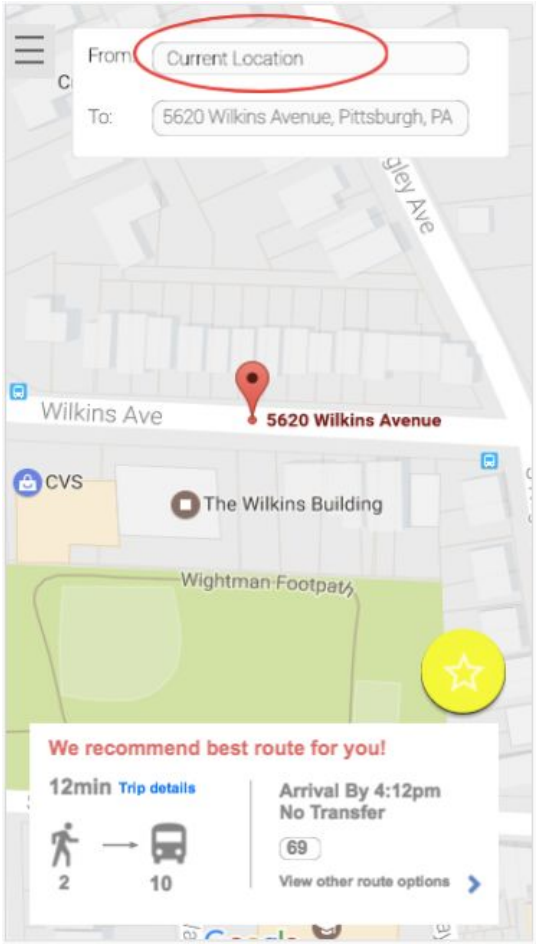
Design Considerations:

According to Professor Sadeh's lecture notes, the factors of developing a success mobile application include: personalization and user-centered design. We summarized several crucial considerations of the UX design process which highly concentrated on enhancing personalization and understanding context of use.

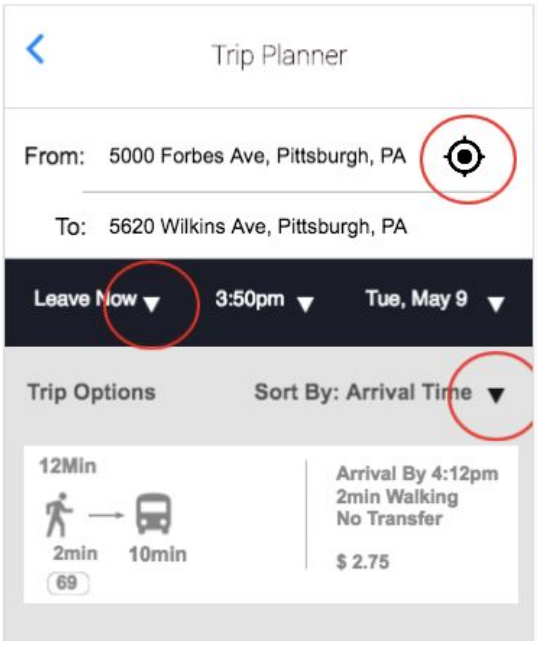


1) One of the key findings in mobile design process is that users will give you a minute to determine whether they like the app, and they are more likely to move away from heavy setup phases. This means the developers need to minimize set ups steps. By considering the importance of minimizing start-up phase, we intended to put location search bar(figure a) on the top of the landing page which is more visible for users to scan, so they are able to quickly find the search bar and plan the trip straight away.

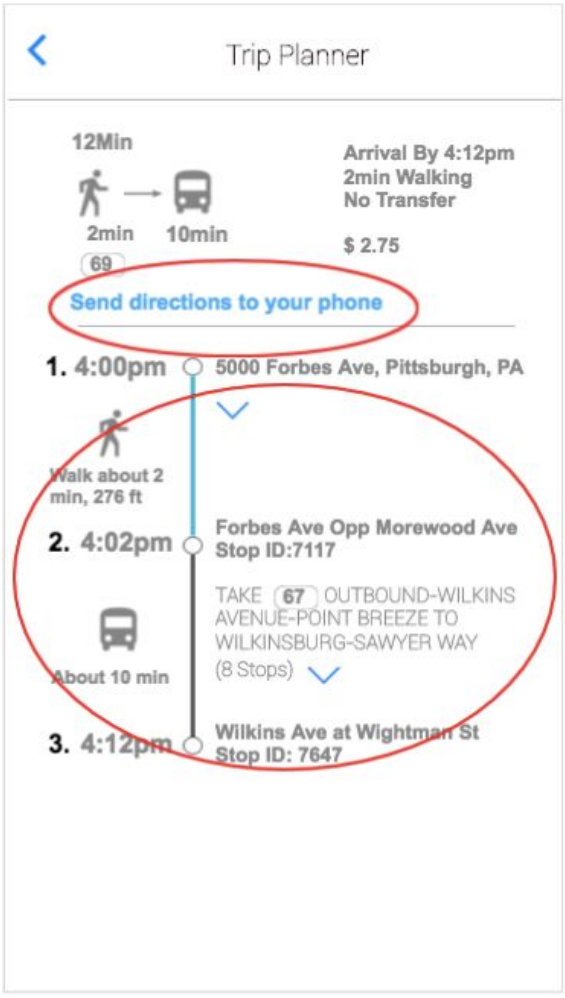
2) According to Nielsen Heuristics (Jakob Nielsen, 1995) evaluation, the rule of "matching between system and real world" indicates that the system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. So we make the system to display the information in a natural and logical order, for example, the search bar notify users to input destination by asking a real world question "Where to go?". At the bottom of landing page, we designed a grey bar to inform users the way of using alert feature. Again, the instruction information appeared with the real-world convention and asked a question "Want to get daily transit alert?", which sets the context and speak the everyday language.



3）After user typed the destination location in the search bar, the system will identify user's current location and then return the recommended route for user. Compared with other trip planning applications which begin with requiring user to input the starting point address, the Bus Talent makes the trip planning process in a more convenient and quick way. The system will set the current location as starting point by default and return the best route for user instead of displaying all available trip options. Because user wants to get to the point, this mean the developers need to consider how to make task simple and provide good shortcuts that are meaningful related to longer procedure. However, user can always change the starting point location in the search bar and retrieve new trip directions. We believe, by providing a more direct mode of planning trip, the user will tend to stick to using that.



4) When designing the interface, developers shall consider creating a minimalist design while ensuring all the information that's being presented on the page is relevant. However, sometimes adding more information means having less white space for minimalist design. Therefore, we decided to utilize visual cue to make objects, options and actions more visible. For example, the upside down triangle indicates the drop down list of time selection, the encompass icon indicates the current location.



5) Network awareness means good user experience in any context, we don't want our mobile app turns completely useless if users lost/turn off the internet connection. In addition, the result of user survey shows that less than half of the users have unlimited data plan, this mean the users without unlimited data plan might be more care for about data usage if they are not on wifi. Therefore,the app should sense the context of internet connection, and be able to react the changing network conditions, offering potential quality of service differentiation without network support. Based on the trip planner use case, we extends it with 'send directions to your phone' feature, so the user can get text message of the trip details on the phone and check it later without an internet connection. The second network awareness feature of the app is the trip planner will initially display the text of trip details instead of loading map. On the other hand, we learned that the user satisfaction is inversely associated with loading time, so loading the map initially might waste time in the condition of bad internet connection. However, our users can always click the blue triangle icon to see the navigation on map if they would like a more intuitive way for direction.

Quality Attributes

Security

Security is the ability to enforce authorization, authentication and ensure data and services are not compromised. Personal data (location) of the customer is transferred from the client apps to Web server, and is susceptible to be captured and misused. Any breach in security would cause monetary damages to PAAC and loss of credibility with customers.

Performance

Performance of software architectures can have multiple dimensions such as short response times (low latencies) and high throughput along with low utilization. There are multiple request-response transpiring between the client and the server of the PAAC, high latencies would lead to inaccurate locations of buses or delayed notification of bus alarms, making the alarm service unreliable.

Reliability

Reliability is measured as mean time between failures. For most components, the measure is typically in thousands or even tens of thousands of hours between failures. The meantime between failure for PAAC mobile app would be the minimum of mean times among all its components. Reliability is affected by software components as well as hardware. The meantime between failures for hardware components is generally listed by the manufacturer but for software components it can rise of various situations like race conditions etc. To test the reliability of software components rigorous testing for different scenarios is crucial. PAAC should be able to cope up with failures in not more than 3 minutes. For PAAC any unanticipated failure could lead to loss of reliability.

Scalability

Scalability is anticipating increased load on a system. A potential overload of the systems due to limited scalability harms availability and reliability. The essential technique for ensuring availability and reliability is redundancy and the overprovisioning of resources, this is very similar to horizontal scaling. Spare resources allocated for availability and failover cannot be used for achieving scalability at the same time. PAAC should be able to deploy new servers when the load of requests on the system increases.

Concurrency is a feature that can make an application scalable.

Availability

High availability is a quality that aims at the indentured availability of a system during a certain period. It is often denoted as percentiles of uptime, restricting the maximum time to be unavailable. Availability and reliability go hand in hand when ensuring the quality of the system. High percentiles of uptime can be achieved by redundancy and anticipating failovers.

Read more about quality attribute scenarios in Appendix B.

Privacy and Security

When it comes to mobile application developing, protecting the privacy of users and securing the application are becoming increasingly significant because of many persistent threats. As app developers, in order to develop a secure android app, we have to be vigilant about security to protect users and understand how to avoid security and privacy issues most affecting our target users.

Privacy: Minimize number of permissions the app needs

Android apps request "permission" from users to access either the hardware features of a smart device, such as the camera, or a user's personal information, while the degree of user awareness of permission issues becomes higher. The Bus Talent will require phone's GPS for navigation and access other personal data components such as home address etc. Accordingly(J. Lin, B. Liu, N. Sadeh, 2014), a user's willingness to permit access to his/her location will vary based on whether the request is required to support the app's core functionality. The research shows that the conservatives users felt uncomfortable with mobile apps that want to access their sensitive data even if for internal purposes only, while nearly 50% of participants felt neutral about letting mobile apps access sensitive personal data for internal functionality purposes. From a developer's perspective, it's always critical to minimize the number of permissions that the app requests. In general, if a permission is not required for core functionality of our app, we prefer not request it. But if there is a function that app can't run without, the android developers document suggest to use a <uses-feature> element in the manifest file. By restricting access to sensitive permission, the developers are able to reduce the risk of inadvertently misusing those permissions, enhance user adoption, and enable the app less vulnerable for attackers.

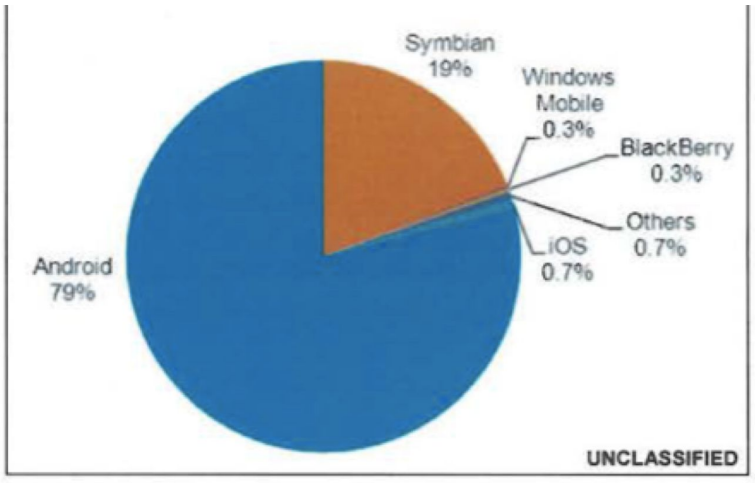
Security: Encryption

In rooted android devices, restricted application space can easily be accessed (Shubhashish Reliant Tekk, 2016). That means the data should never be store in the form of plain text. Most of the developers know the importance of protect app code with encryption, but the technology is constantly changing, as a result, encryption algorithms

become obsolete and easier to crack. It's highly risky if developers do not to use encryption at all in the app or use weak encryption, because the information can be hacked easily without good encryption. So, Bus Talent will invest in well-supported algorithms coupled with API encryption in the future. As stated in professor sadeh's lecture notes, Mobile risk management company Fixmo has launched a new software development kit to protect private data on both Apple iOS and Android devices. The software uses advanced data encryption and policy management to help secure mobile apps against privacy loss, data leakage, malicious exploits and policy compliance breaches (Vance McCarthy). The software allows developers to support a range of enterprise-caliber capabilities for mobile apps including:

- Defense-grade encryption of data-at-rest and data-in-transit using FIPS 140-2 validated AES 256-bit encryption
- Application-level policy management including password controls and security checks to prevent the app from running if the device has been compromised, jailbroken or rooted
- Remote application management including remote lock/wipe commands and custom management policies

Security: Mobile Malware



In terms of security, one of the app-based threat is mobile malware which exploits vulnerabilities or bugs in the coding of the mobile apps. A report by the Department of Homeland Security find that android malware makes up 79% percent of total threats. This issue arises out of a increasing trend of hackers create a fake app to phish for user

information or implant malware. Hackers can reverse engineer on a public copy of mobile app, then place malicious code into the app and redeploy it to the market, as a result, unsuspecting users then download and use the app, leaving their sensitive information exposed to the hackers. To increase malware protection, applying sacristy practices to app developing includes the use of source code scanning tools, can help make apps resilient to malware attack, while it's also critical to analyze code from third parties.(Sub Sthanu, 2015)

Security: Web-based threat

In sensitive applications which use a web service, the most critical thing is to reduce the risk when we communicate with a web service, and make sure that the data we share with the backend is secure. Even the safest application is useless if the requests made over the Internet are easily catchable. Therefore, Android apps that use SSL/TLS protocols for secure communication should properly verify server certificates. The basic verification includes:

- verify that the subject (CN) of X.509 certificate and the URL matches
- verify that the certificate is signed by the trusted CA
- verify that the signature is correct
- verify that the certificate is not expired

References

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Appendix B

Quality Attribute Scenarios

Security

Reason: If the user information is disclosed, their location details could be compromised and may lead to a lawsuit.

Technical Risk: 1 - Low.

Reason: To ensure the security of the system, an additional secure layer or encryption is needed on top of TCP/IP, which increases the complexity of the system and make it harder to maintain.

Raw quality attribute	System security
Stimulus	The users information is obtained by hackers who eavesdrops on the traffic
Source of the stimulus	Malicious hackers
Architectural elements	Connection between mobile app and web service.
System response	The system makes the data unreadable for everyone except the sender and the receiver.
Response measures	The hacker cannot understand the encoded traffic between user and the system

Performance

Reason: If the system has bad performance i.e. long response times the location of buses is compromised and failure of the alarm functionality leading to bad user experience and

Technical Risk: Moderate

Reason: To improve the performance would require deploying redundant servers to handle the increased amount of requests quickly which would increase the budget of the project. Also, we would require time bound software mechanisms to make sure that responds to requests are delivered timely, leading to increased complexity of the system.

Raw quality attribute	The system performance
Stimulus	Large number of requests the server.
Source of the stimulus	All requests
Architectural elements	Client App and Web service
System response	The PAAC uses replica servers and ensures time bound responses to requests.
Response measures	The PAAC is able to generate response in less than 4 seconds to requests.

Reliability

Reason: If the system fails while deployed then all ongoing transactions are lost, if we implement functionalities related to payment then it could lead to losses and decreased credibility.

Technical Risk: 1 - High

Reason: The mean time to failure is depends on the minimum mean time of failure of the systems components. It is difficult to gauge mean time of failure for software component as they depend on end cases like race conditions which reveal themselves via rigorous testing. Hardware components generally have an assigned mean time to failure by the vendor.

Raw quality attribute	The system reliability
Stimulus	Race conditions, end cases for software components. Not monitoring the health of hardware components
Source of the stimulus	Hardware and Software components of the system.
Architectural elements	PAAC system (bus gps, web service, mobile app)
System response	The system should anticipate failures via rigorous testing and health of hardware components should be monitored. In case of a failure the spare hardware components should be available and for software components personnel should be valuable to fix the bugs.
Response measures	Mean time to failure.

Scalability

Reason: The system should be able to handle and anticipate increased load on the system. It should also be easily able to accommodate new customers on odd days. A failure to do so will affect performance, availability and reliability of the system with increased load.

Technical Risk: Moderate

Reason: The essential technique for ensuring availability and reliability is redundancy and the overprovisioning of resources but these resources should be disparate from the resources needed to scale or it would affect availability, reliability and performance of the system.

Raw quality attribute	The system scalability
Stimulus	Increased number of request on the PAAC Web service.
Source of the stimulus	Mobile Apps.
Architectural elements	Servers of the PAAC.
System response	New resources can be added within seconds since the servers are deployed on cloud.
Response measures	The servers should anticipate the need for scalability and new resources dedicated to handle increased load should be added in a few minutes.